Restoration Challenges: Regional Effects of Tidal Marsh Restoration

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DWR

Four Topics:

- Restoration effect on scalar dispersion
- Restoration effect on tidal range
- Modeling examples
- Tidal marsh restoration: good, bad, both?

Take home's

Tidal marsh restoration:

- Changes marsh "geometry"
- Affects tidal propagation over a wide area, in turn affecting:
  - Current motions
  - Tidal range
  - Scalar dispersion

➢ *Process understanding is the key to restoration success.*

“Scalar dispersion”

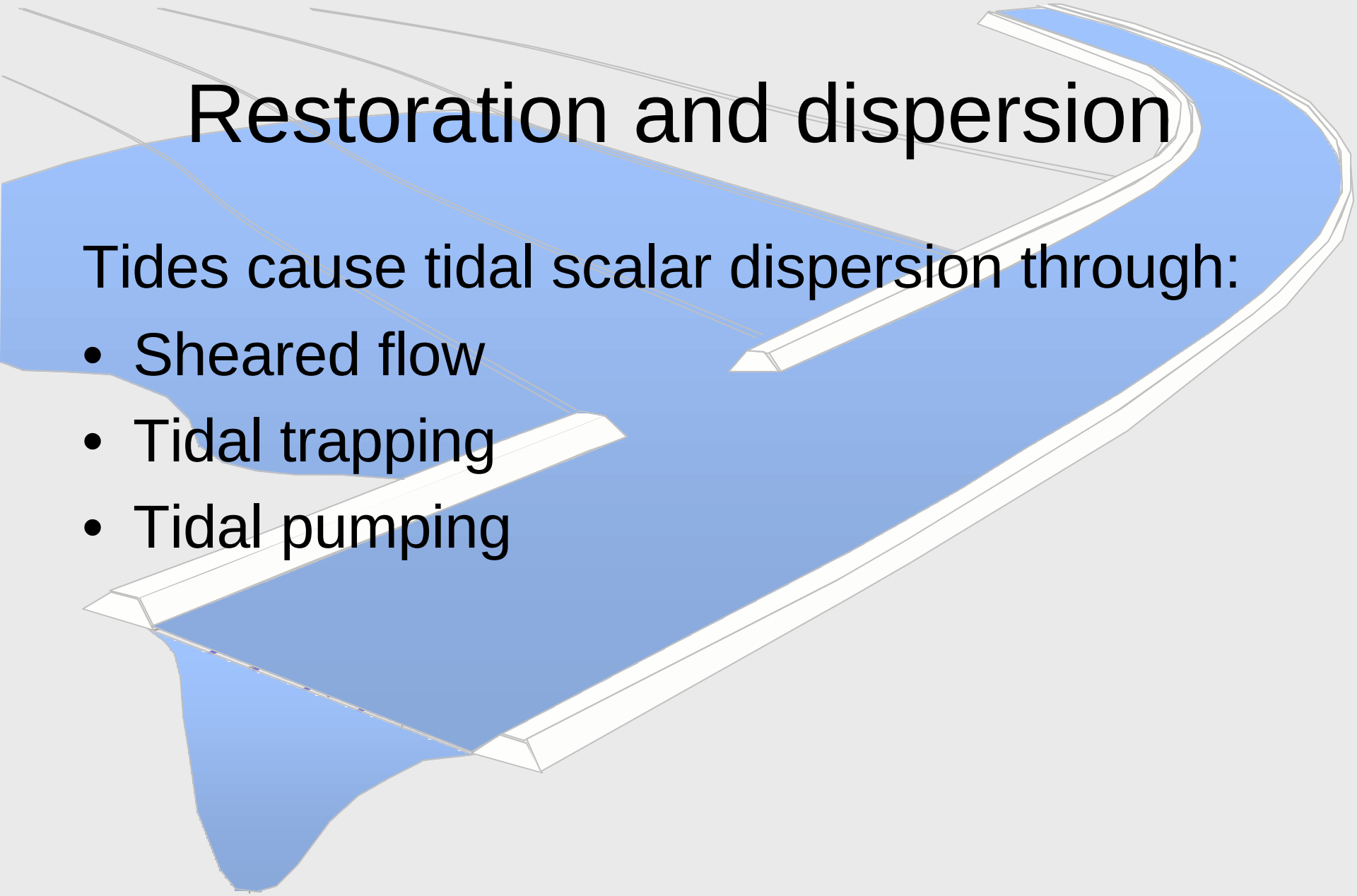
Tidal mixing of the “stuff” in the water

- Scalars include:
  - Salinity
  - Sediment
  - Contaminants
  - Carbon
  - Biota

Forces that cause dispersion

- Tides
  - Meteorology
  - Coastal ocean conditions
  - Density gradients
  - Earth rotation

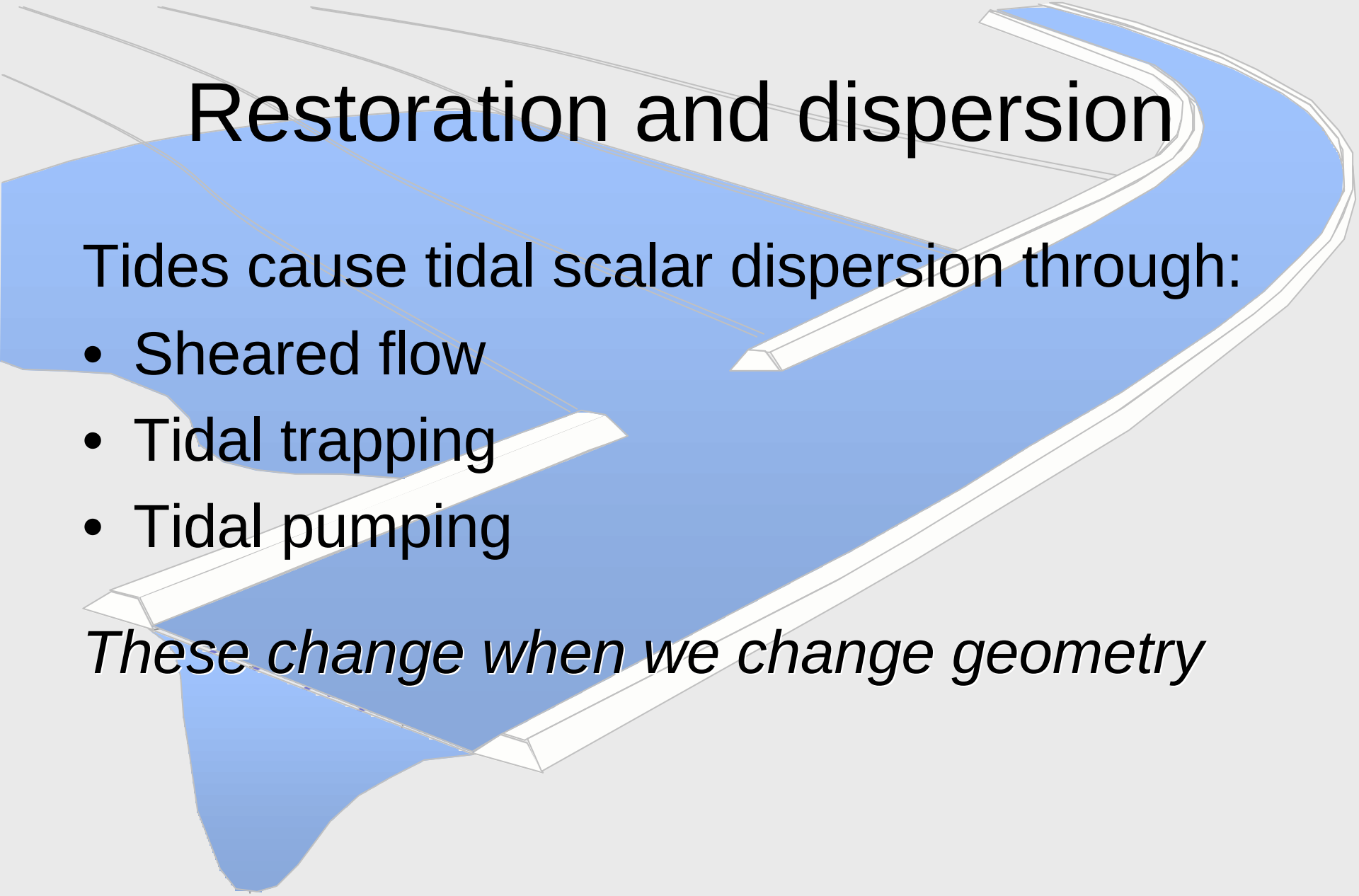
Restoration and dispersion



Tides cause tidal scalar dispersion through:

- Sheared flow
- Tidal trapping
- Tidal pumping

Restoration and dispersion



Tides cause tidal scalar dispersion through:

- Sheared flow
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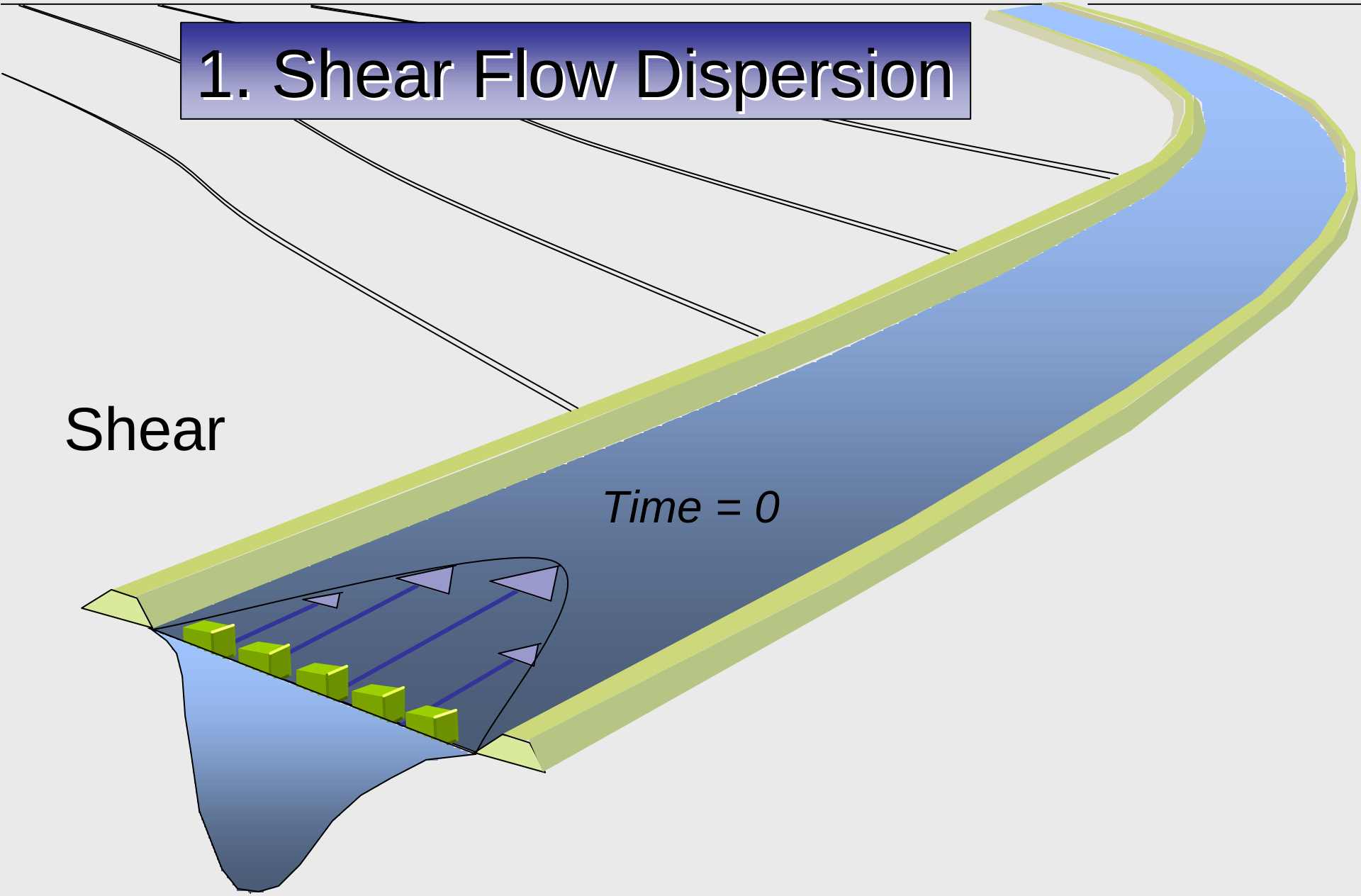
- Tidal pumping

These change when we change geometry

1. Shear Flow Dispersion



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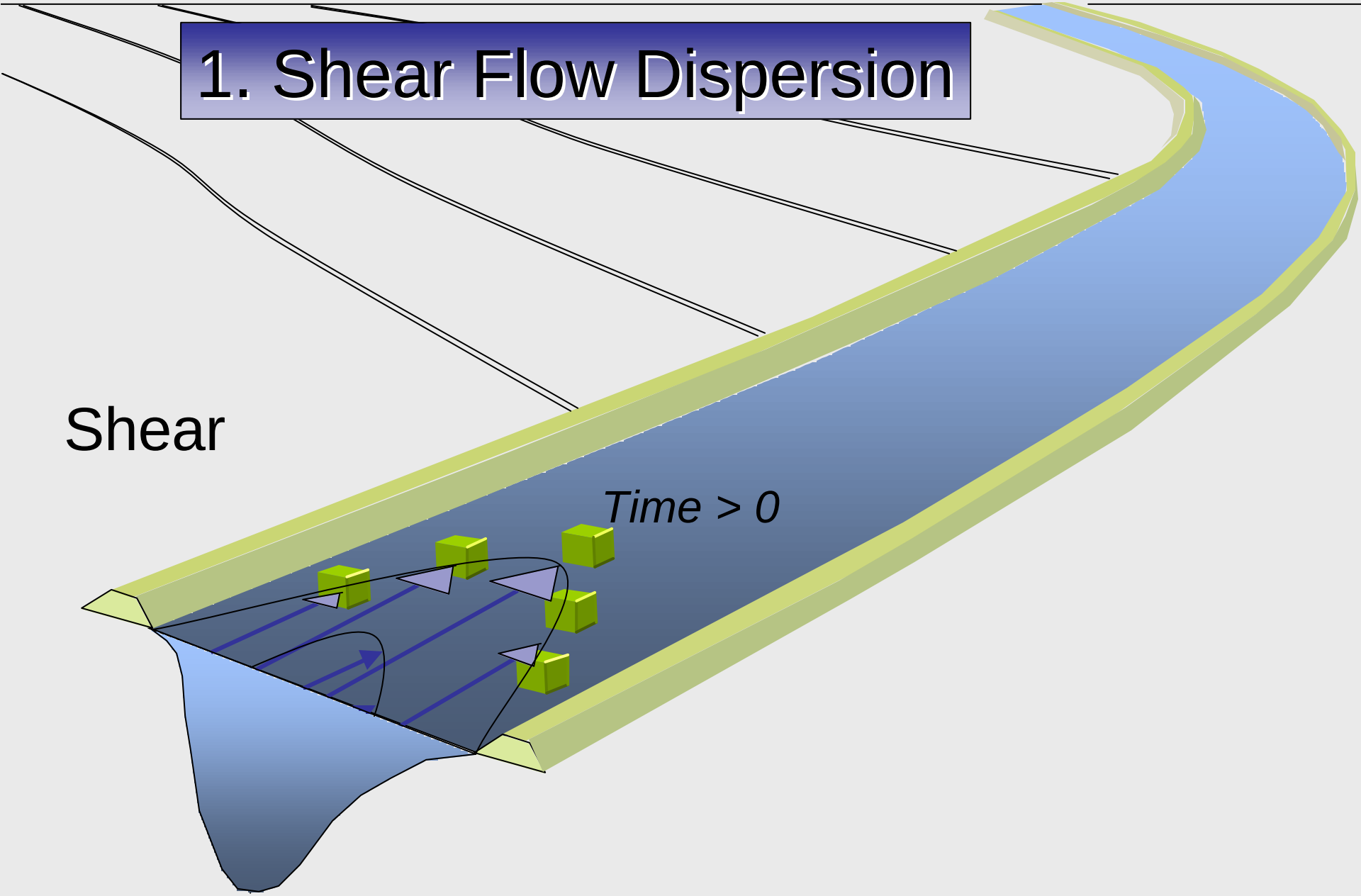

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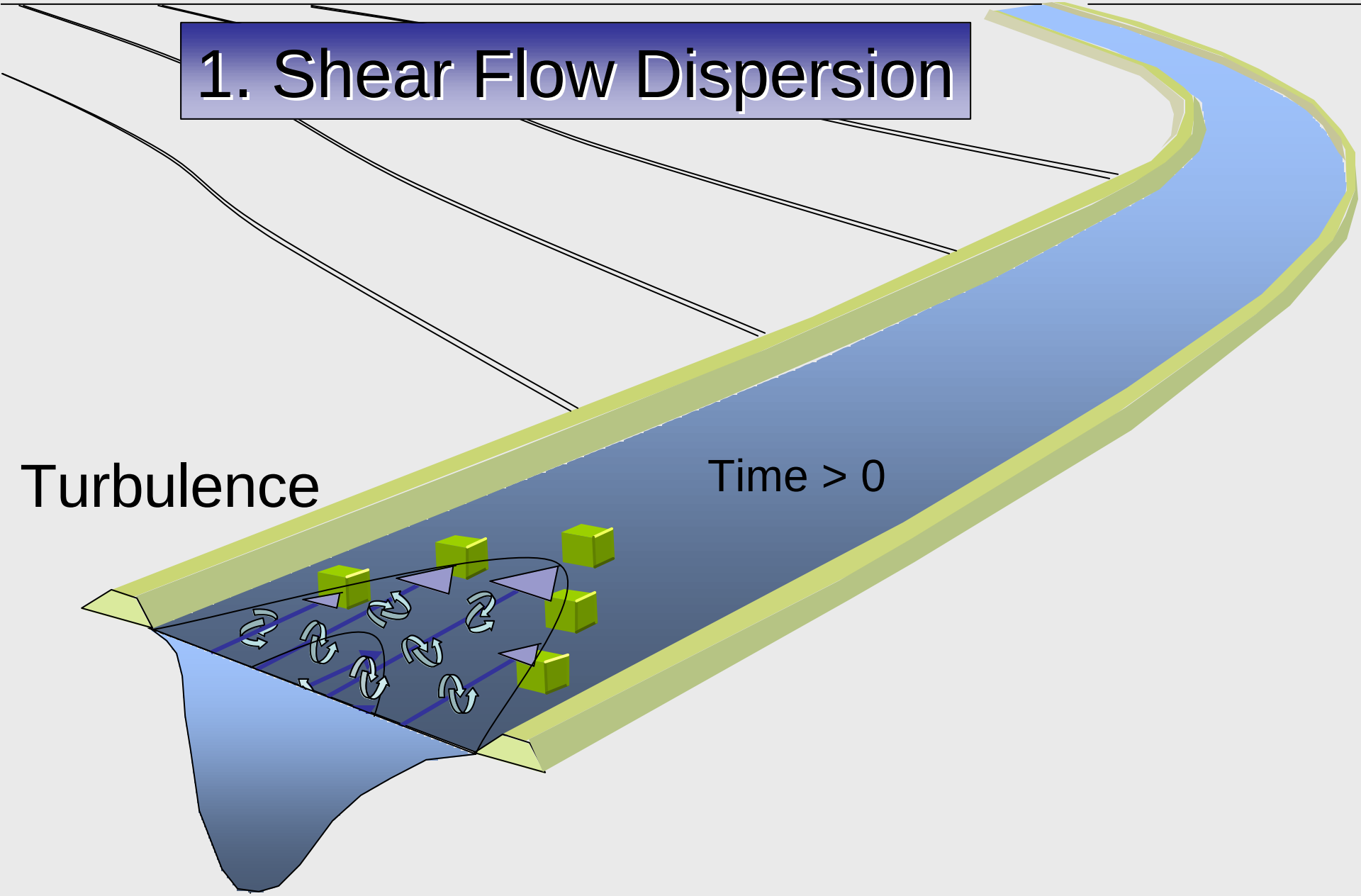

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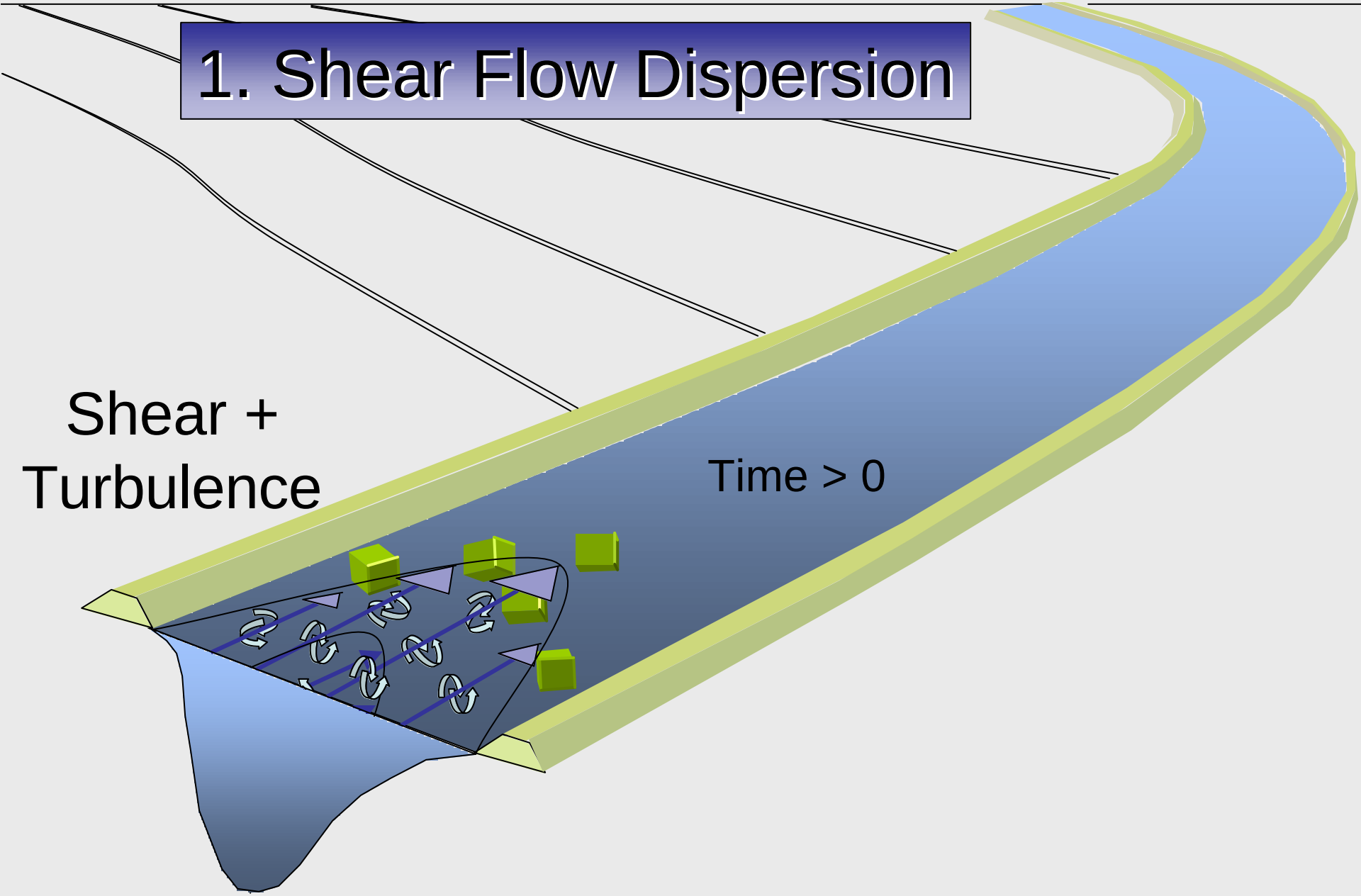

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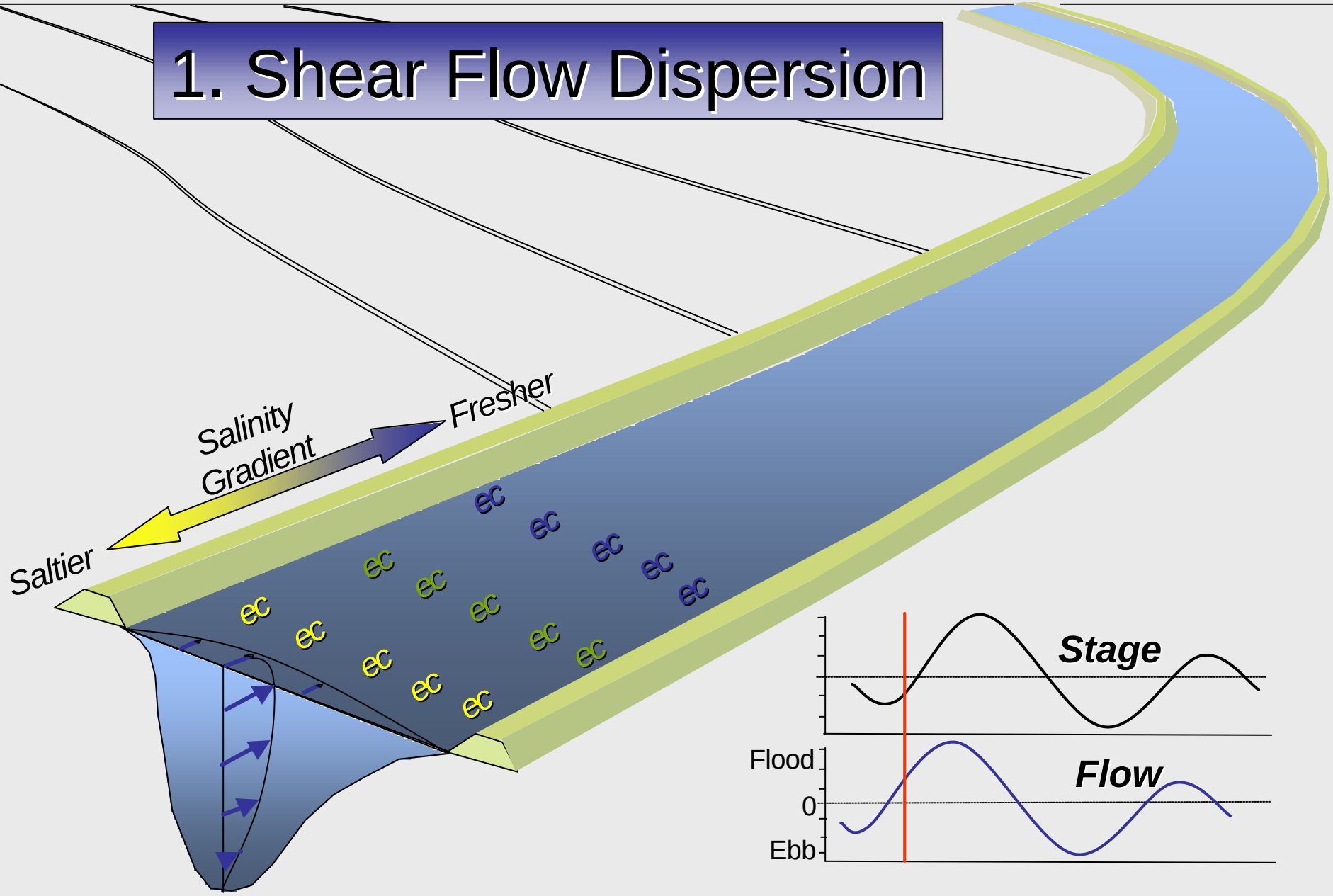

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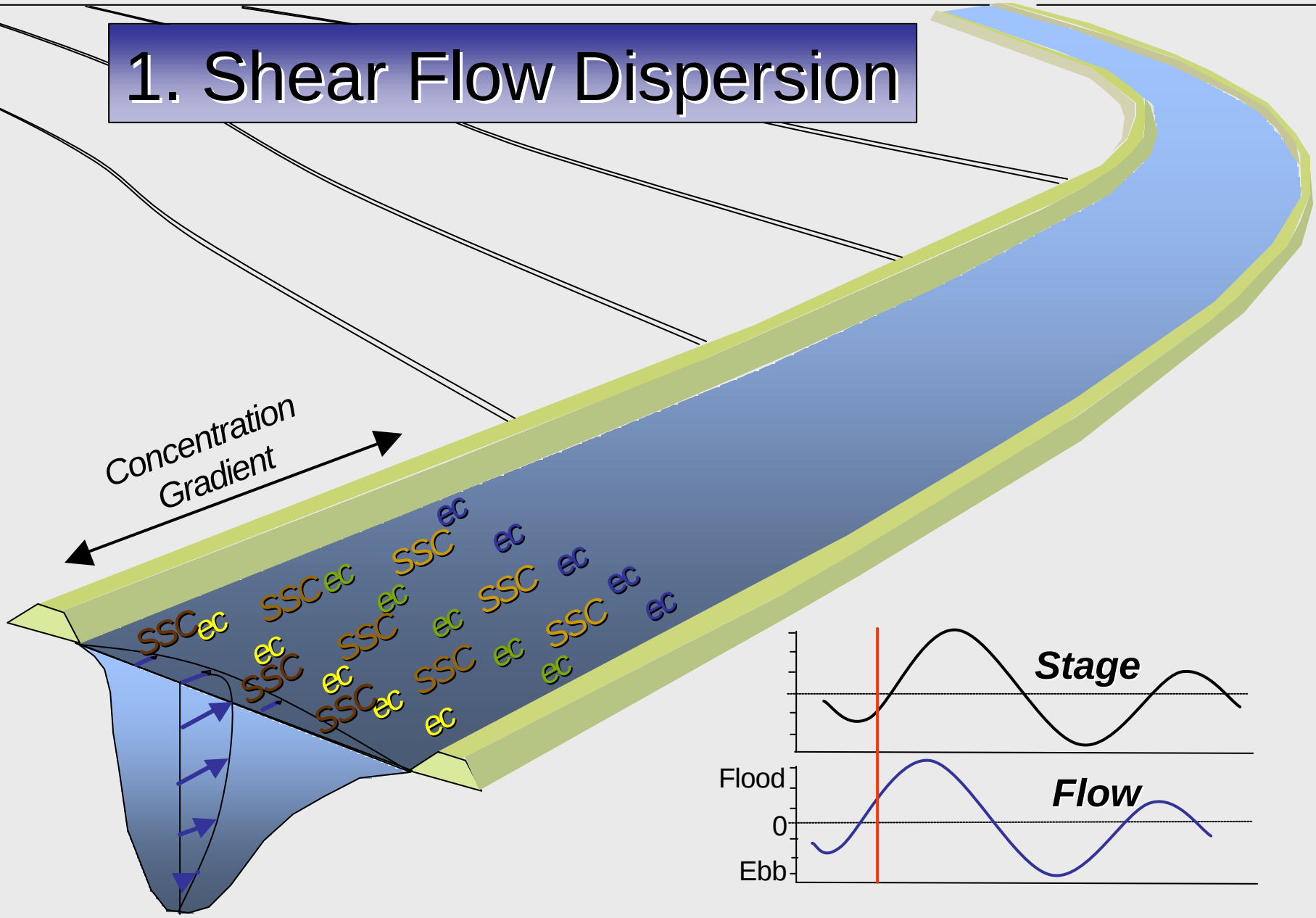

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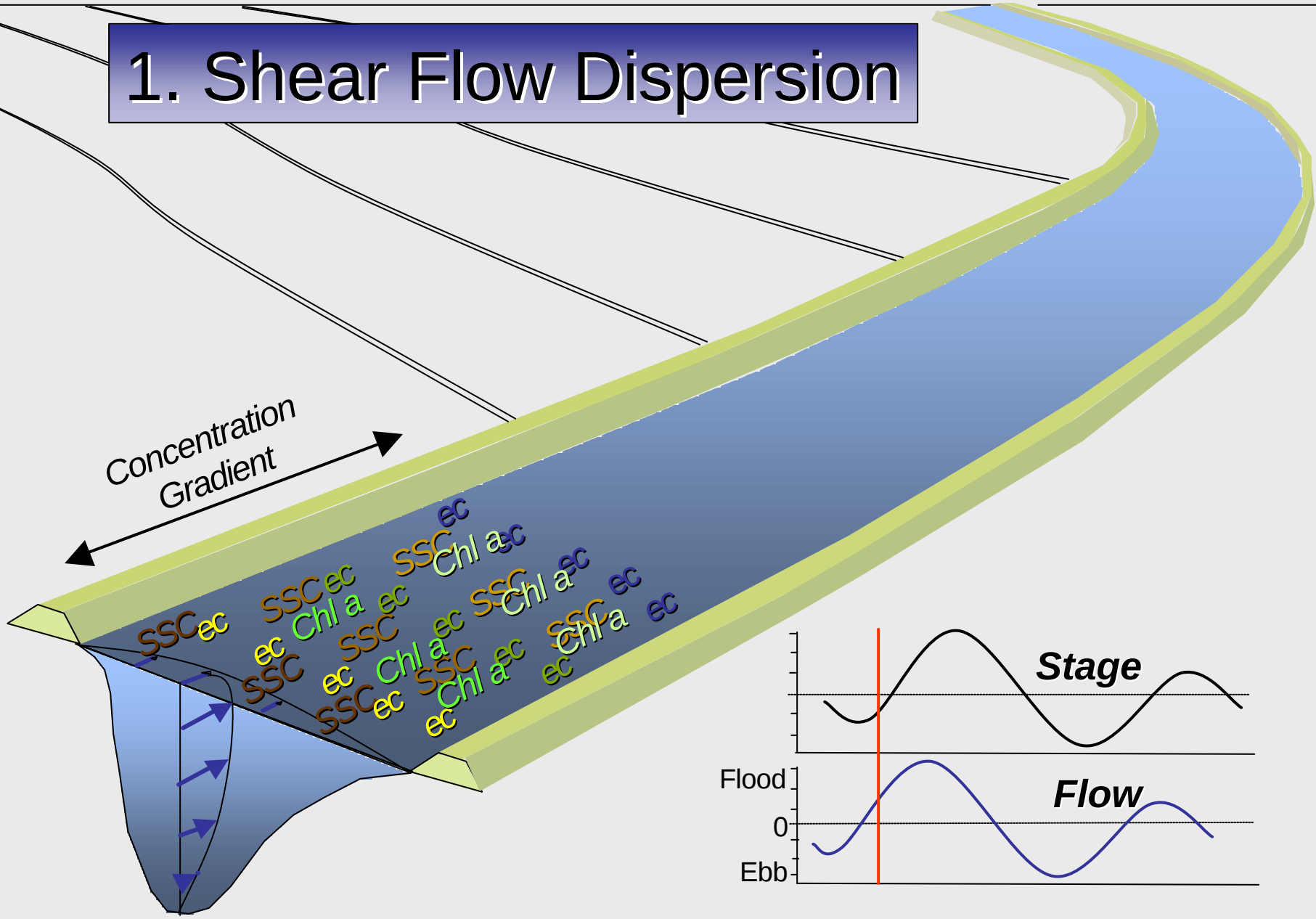

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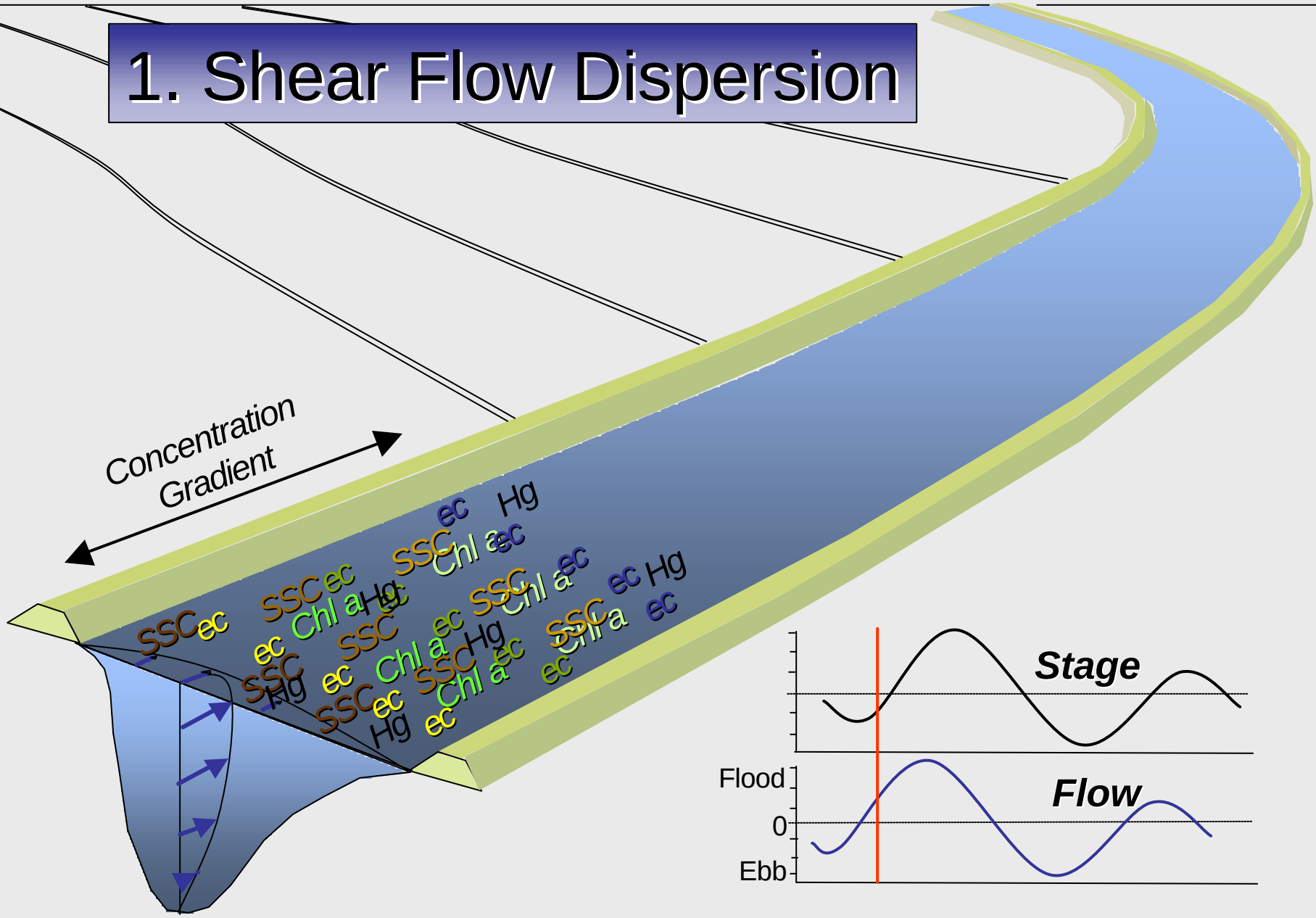

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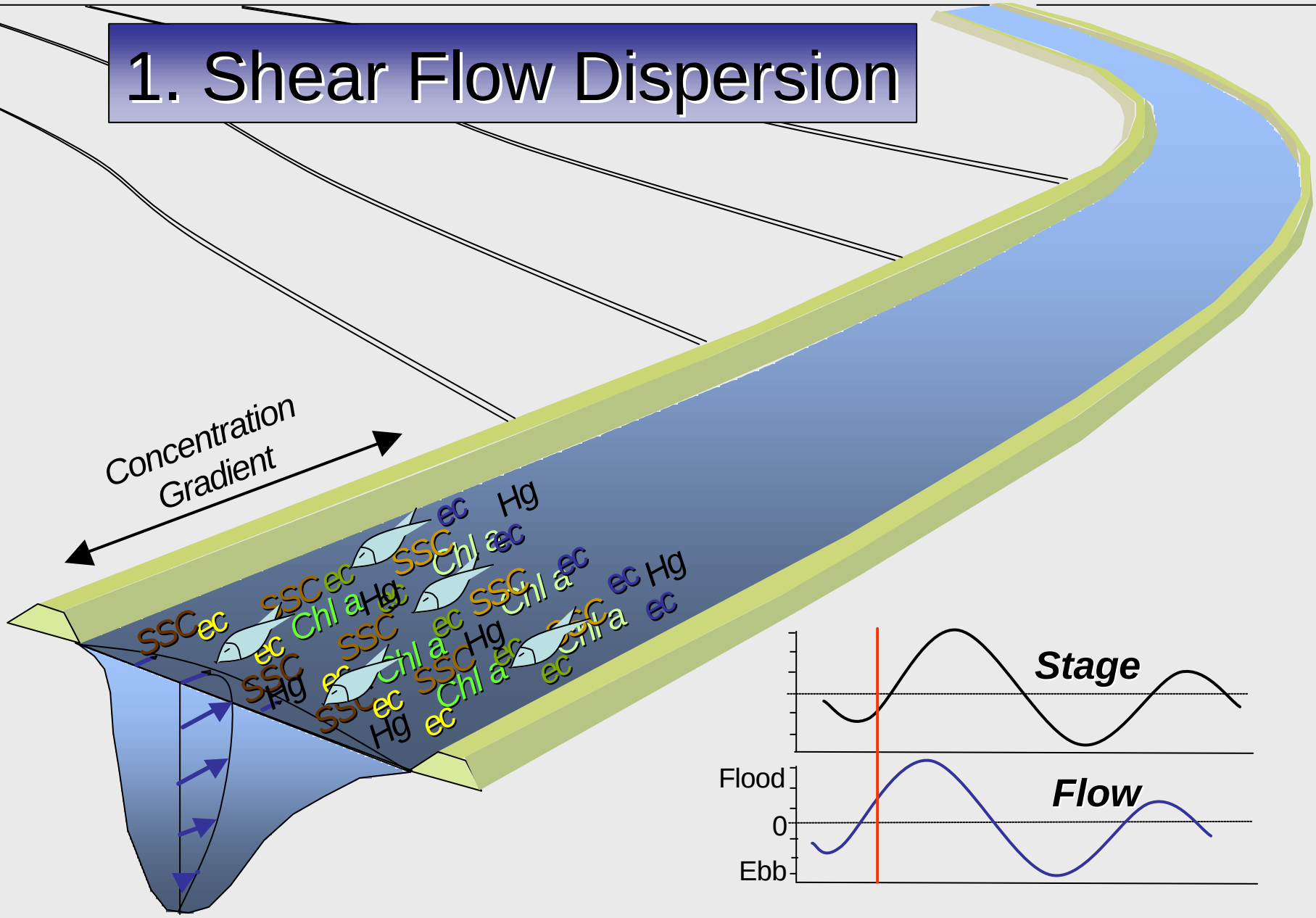

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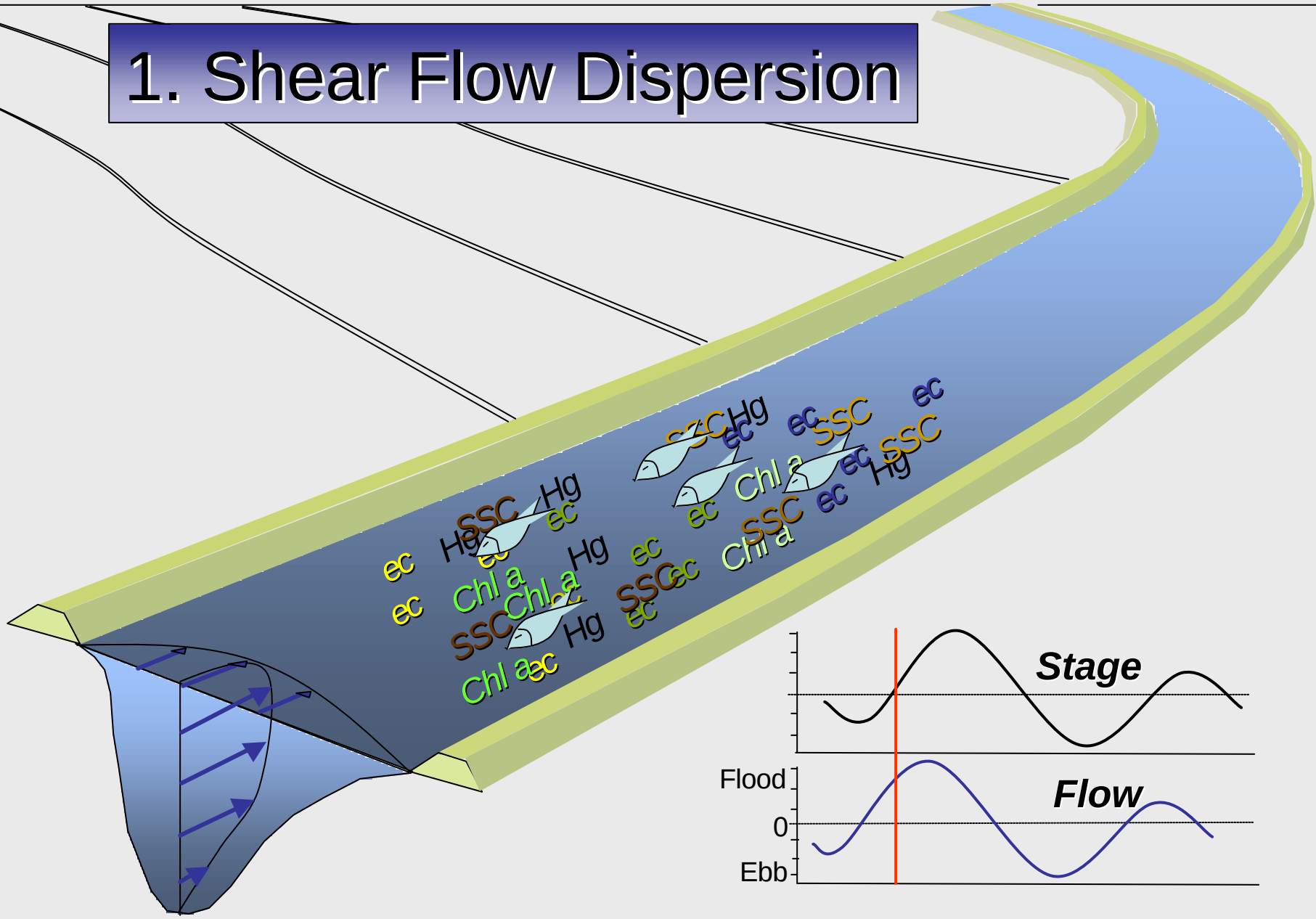

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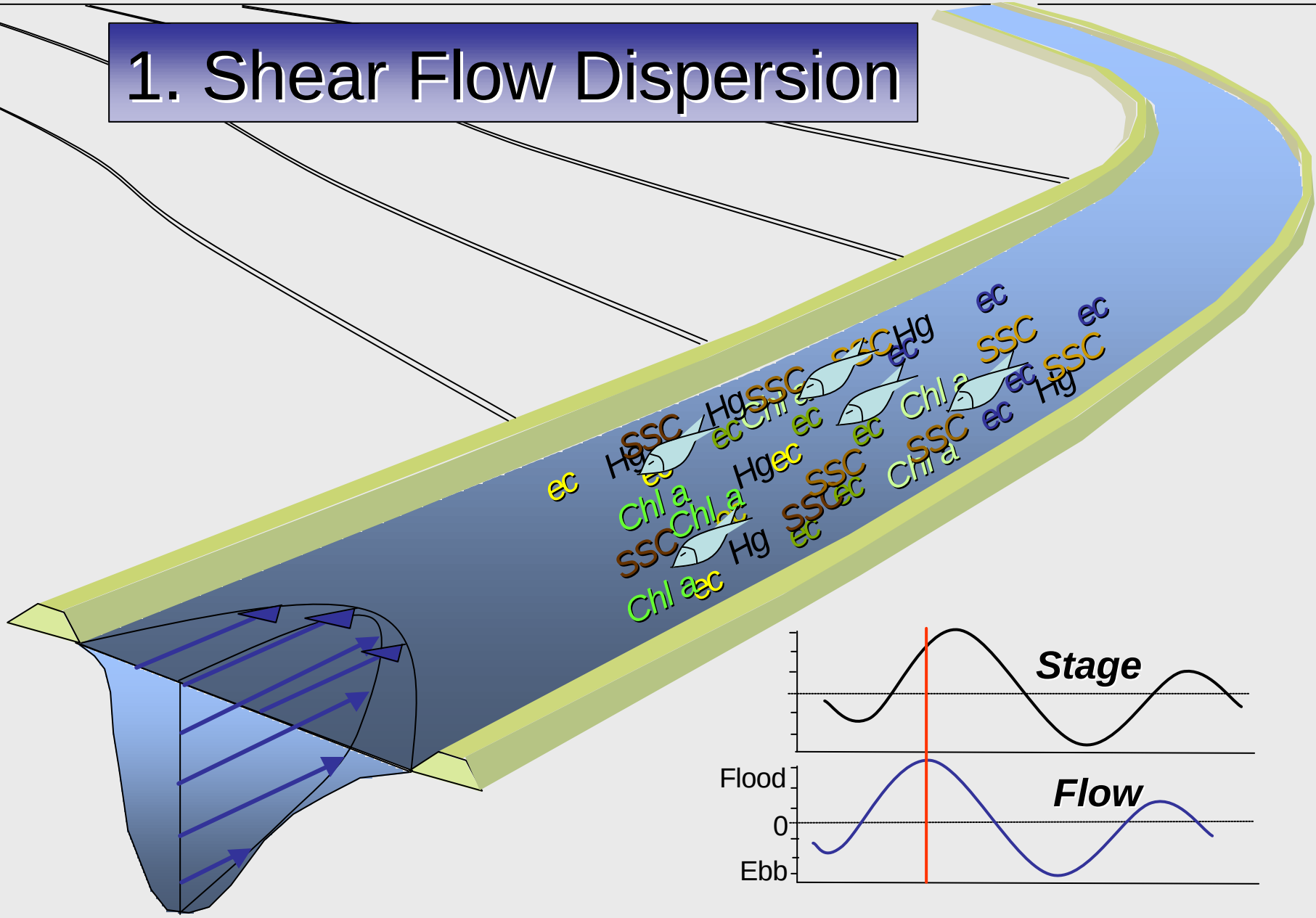

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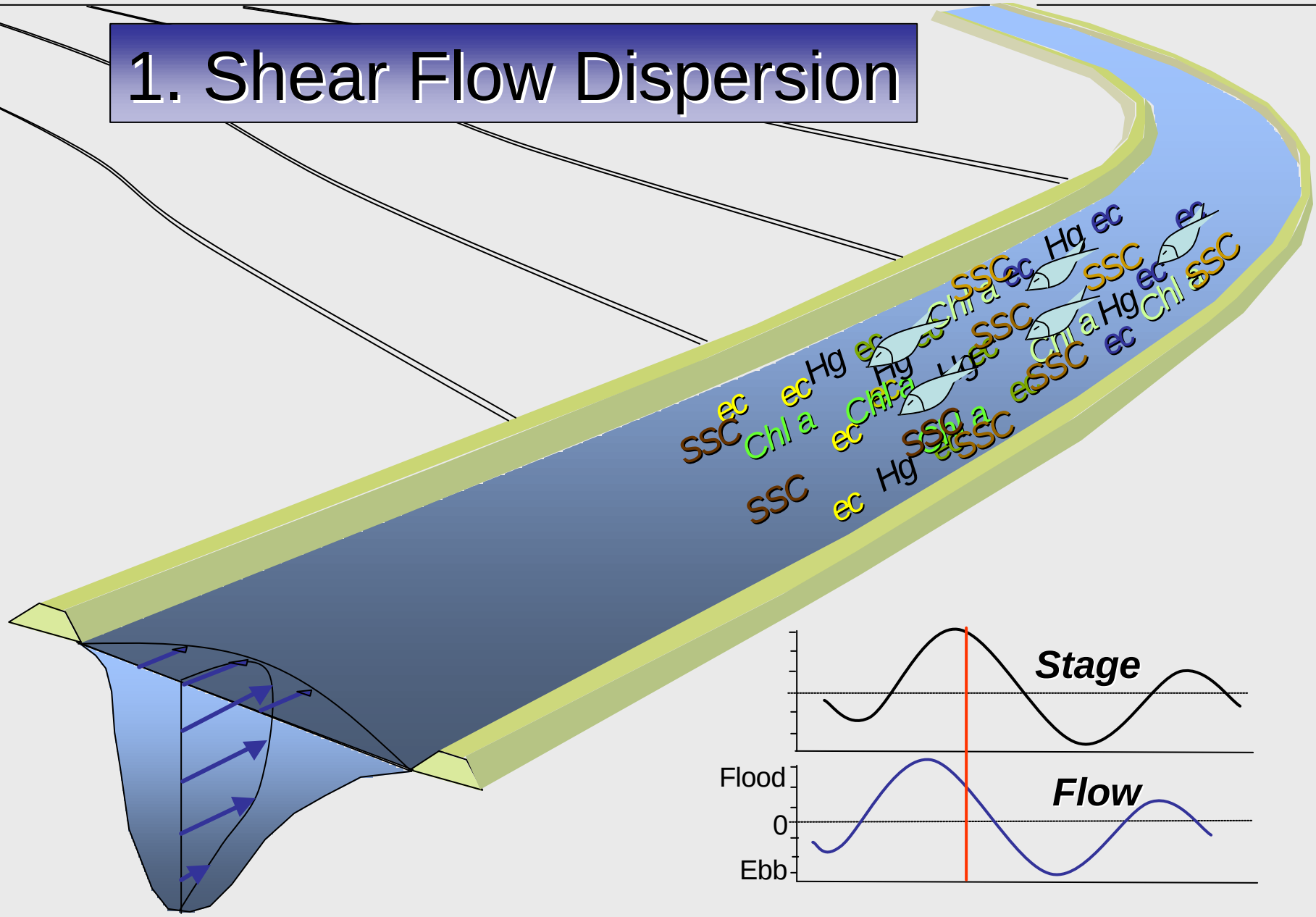

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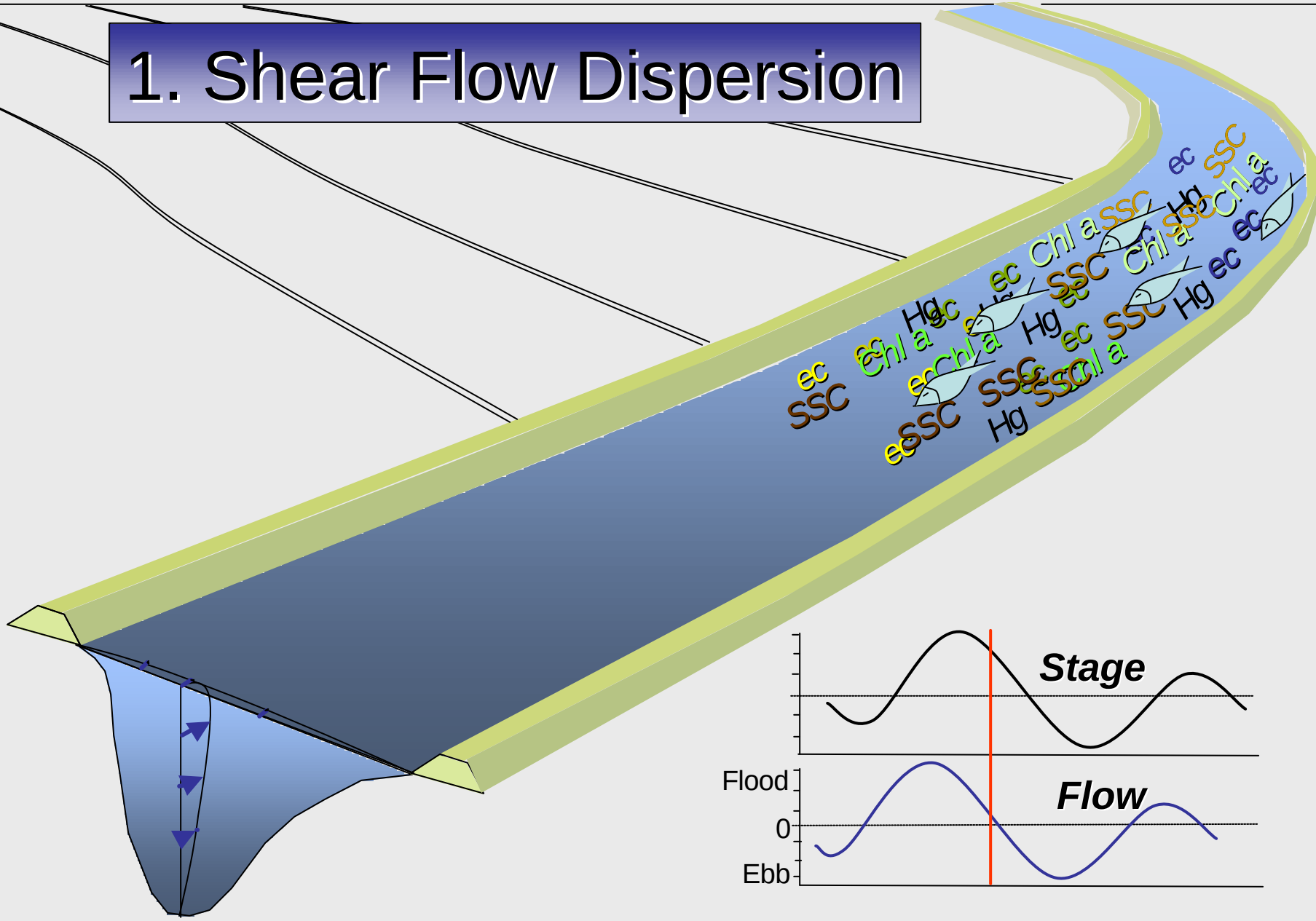

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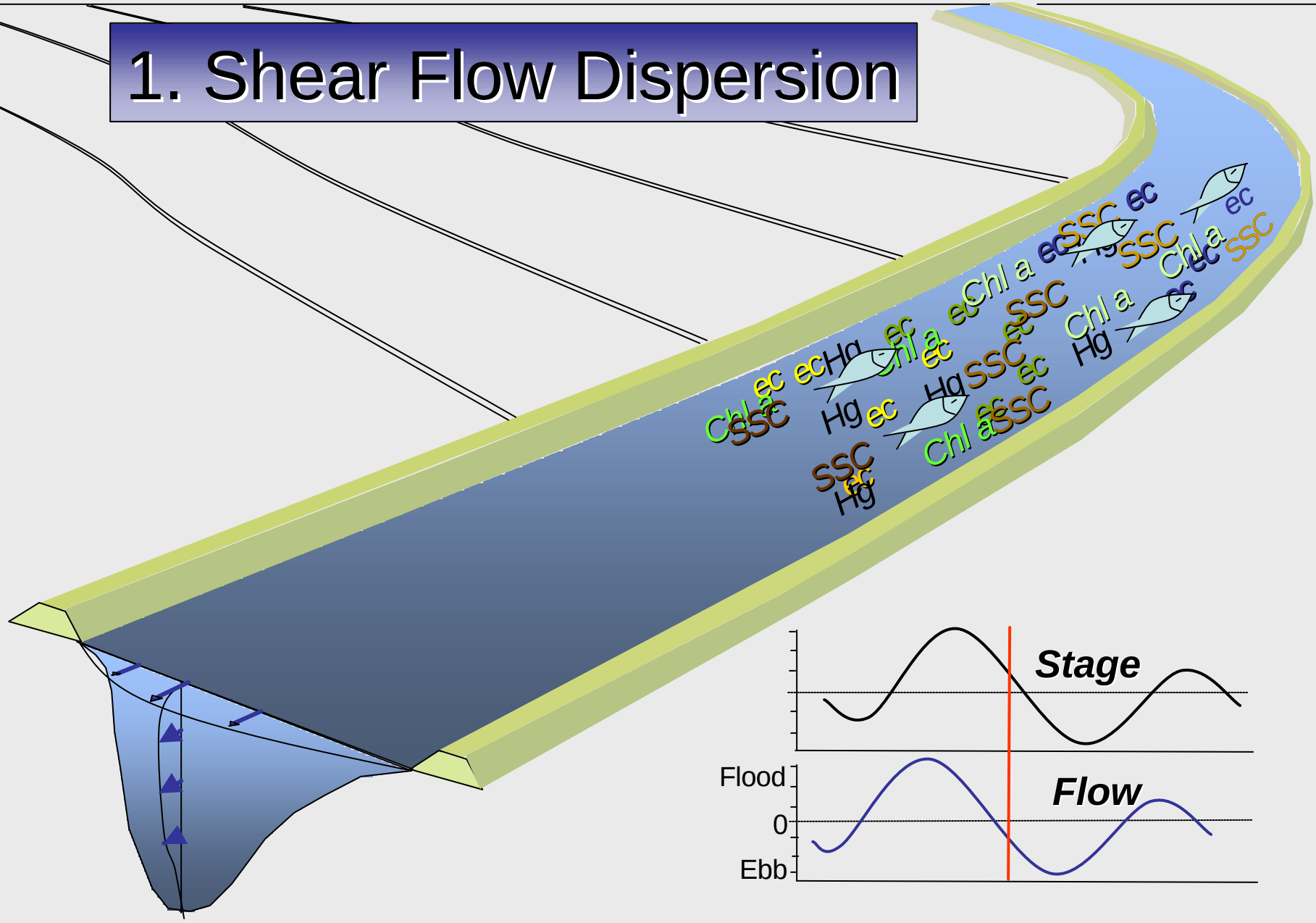

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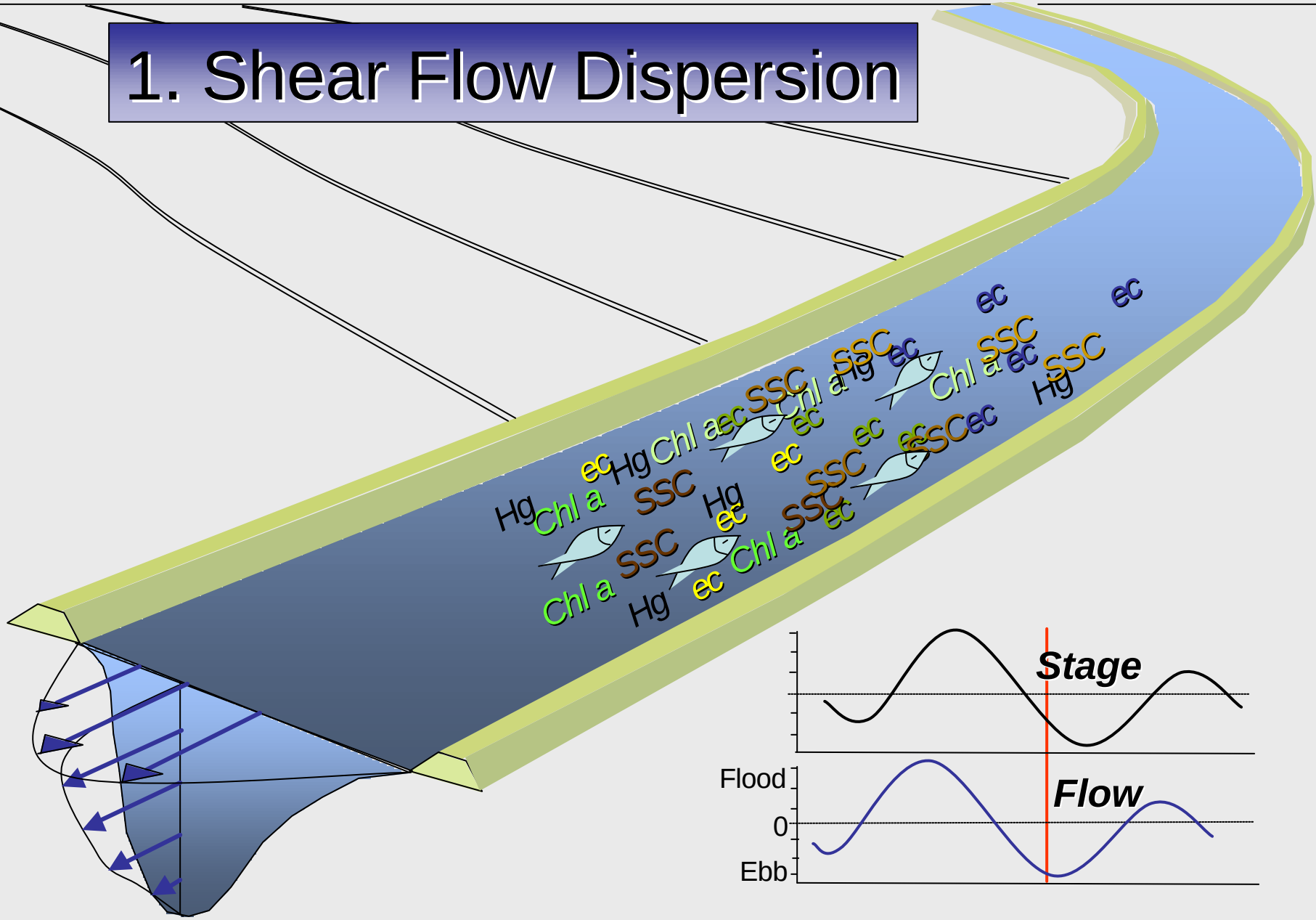

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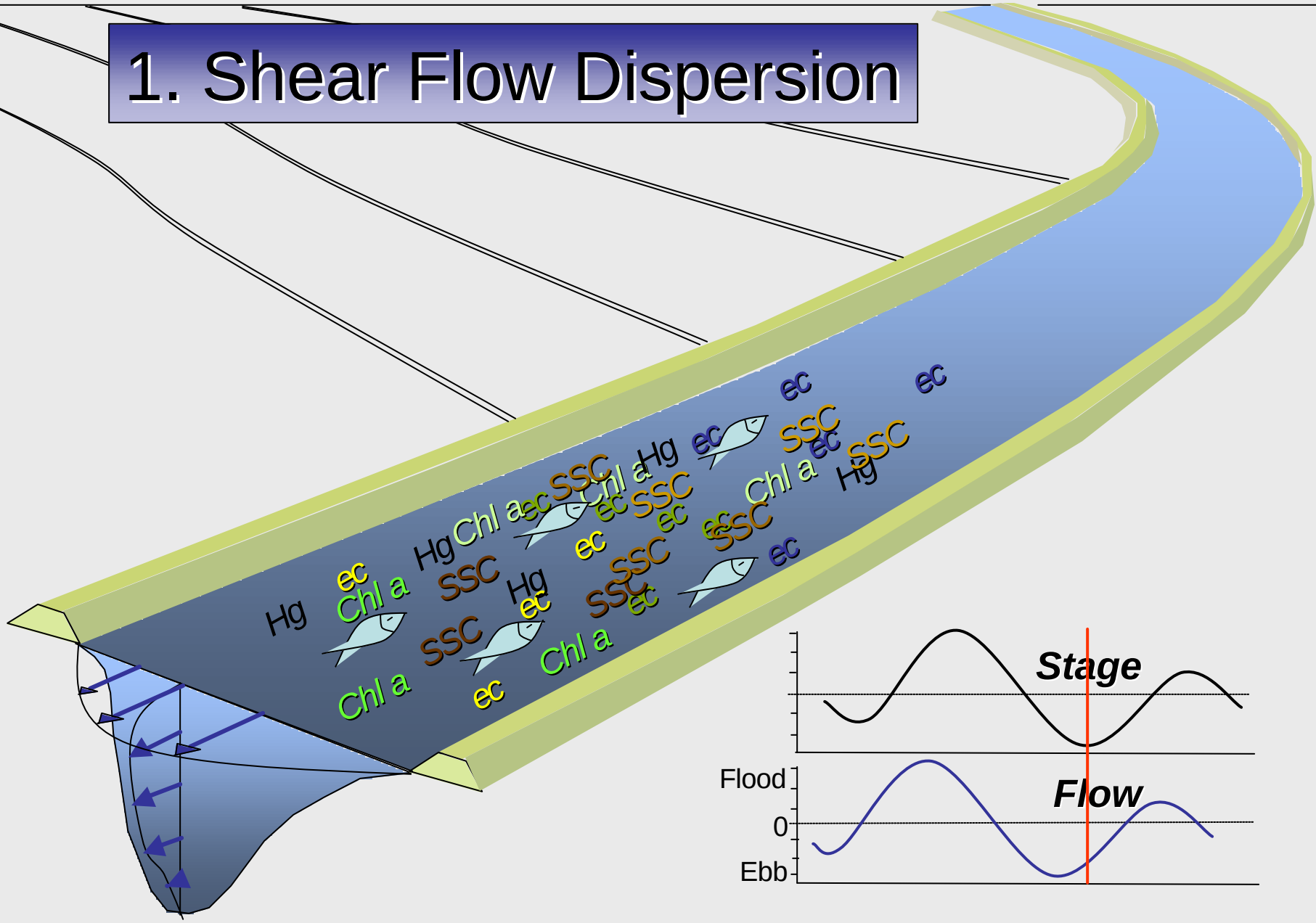

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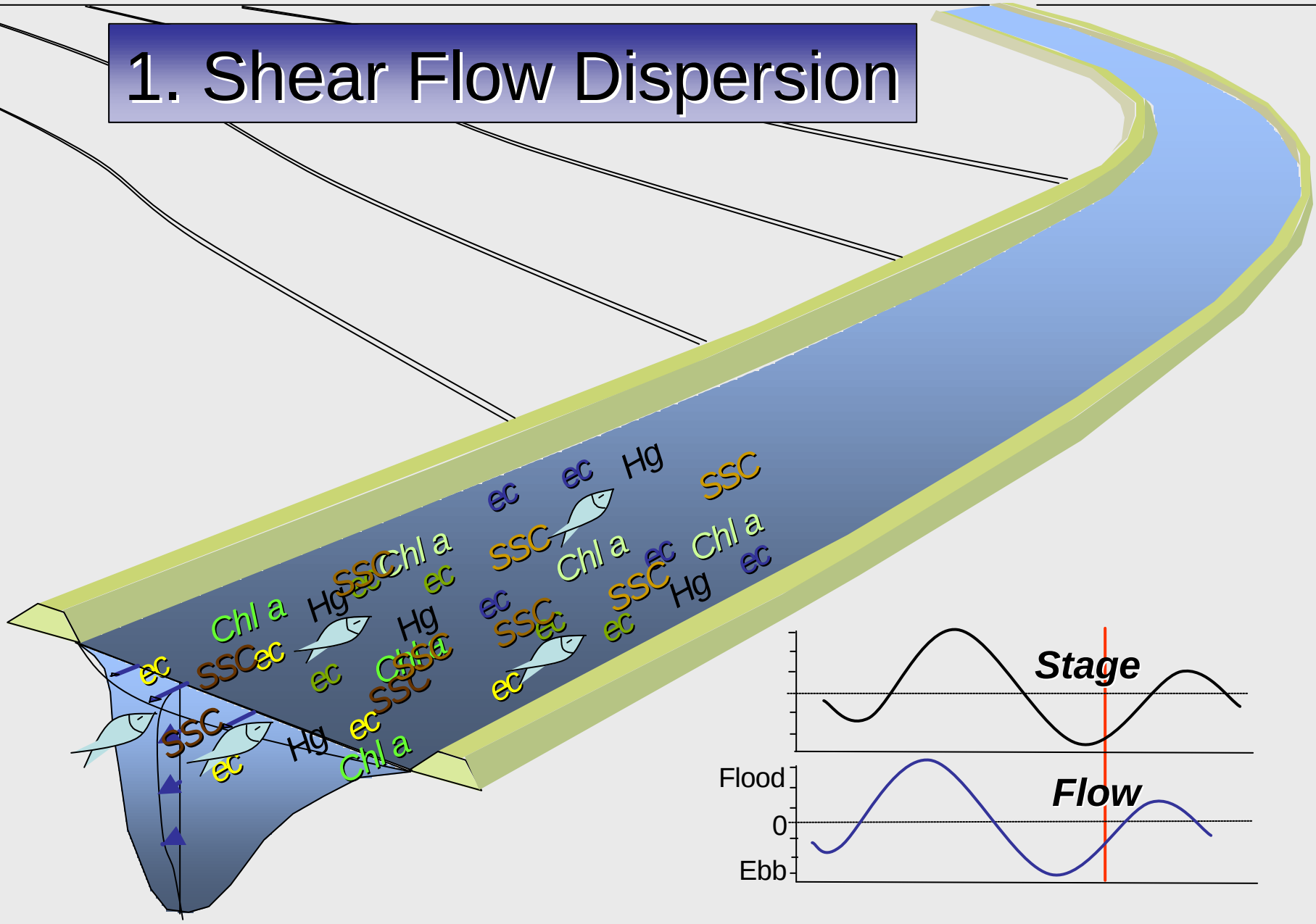

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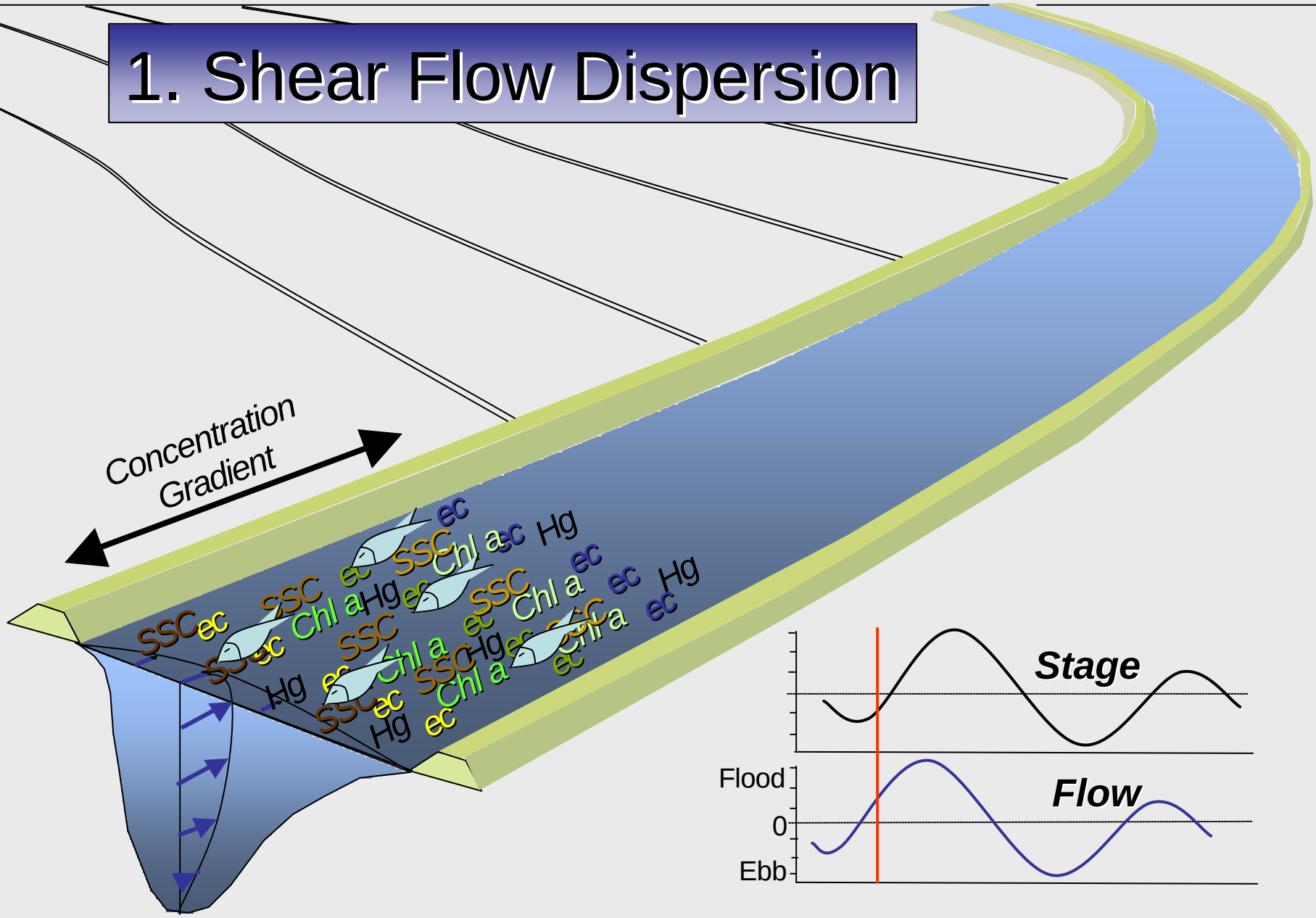

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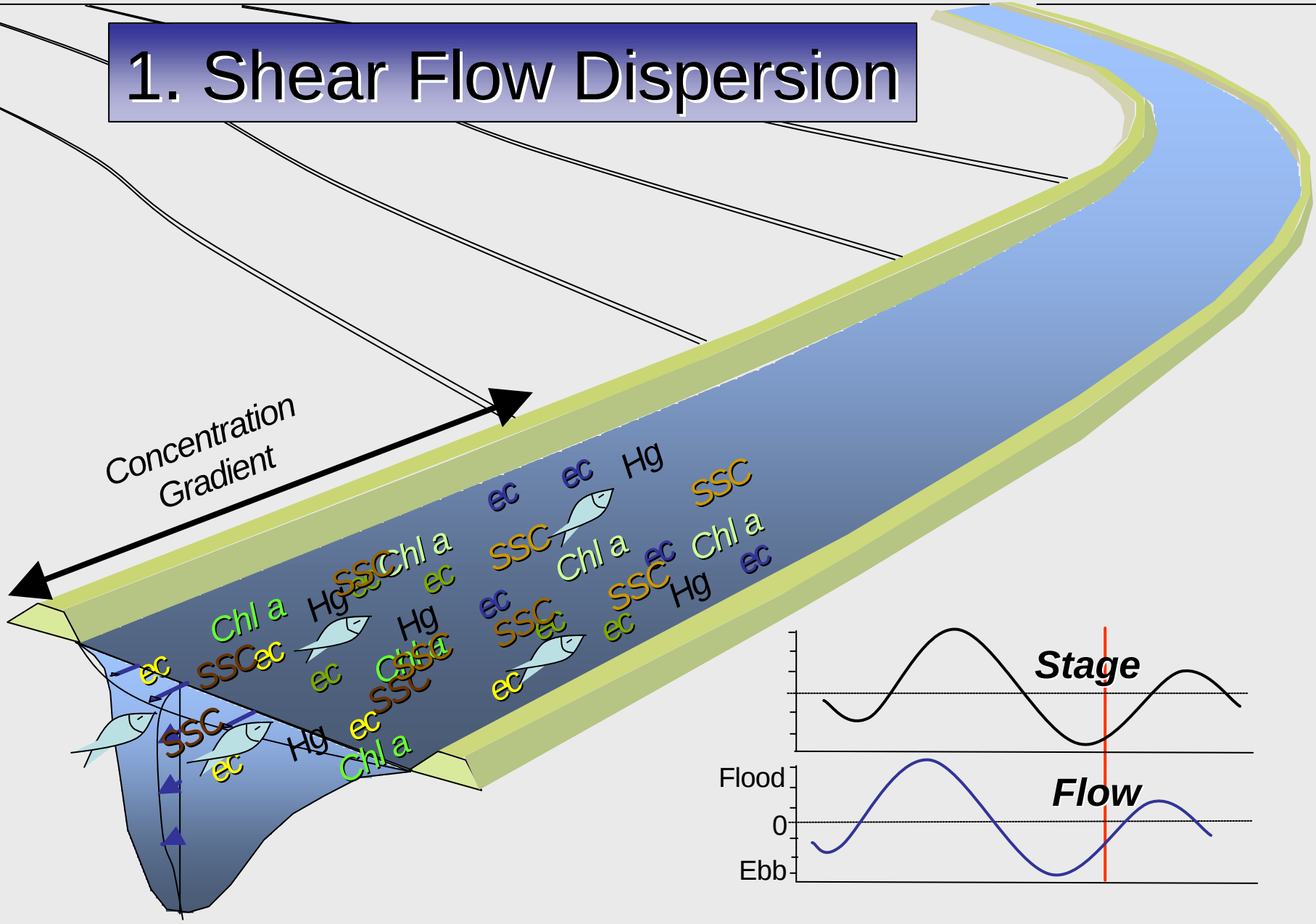
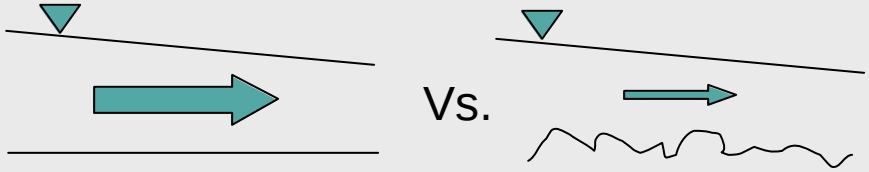


Shear Flow Dispersion is Enhanced by :

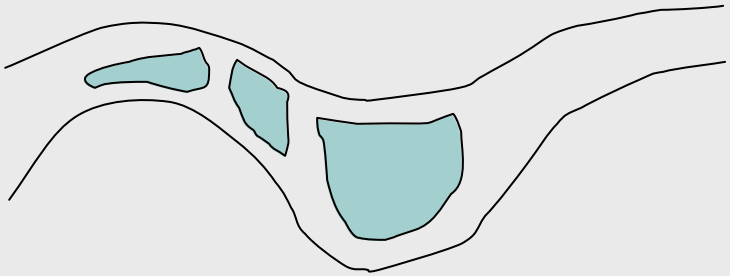
- Sinuosity

- Bottom roughness



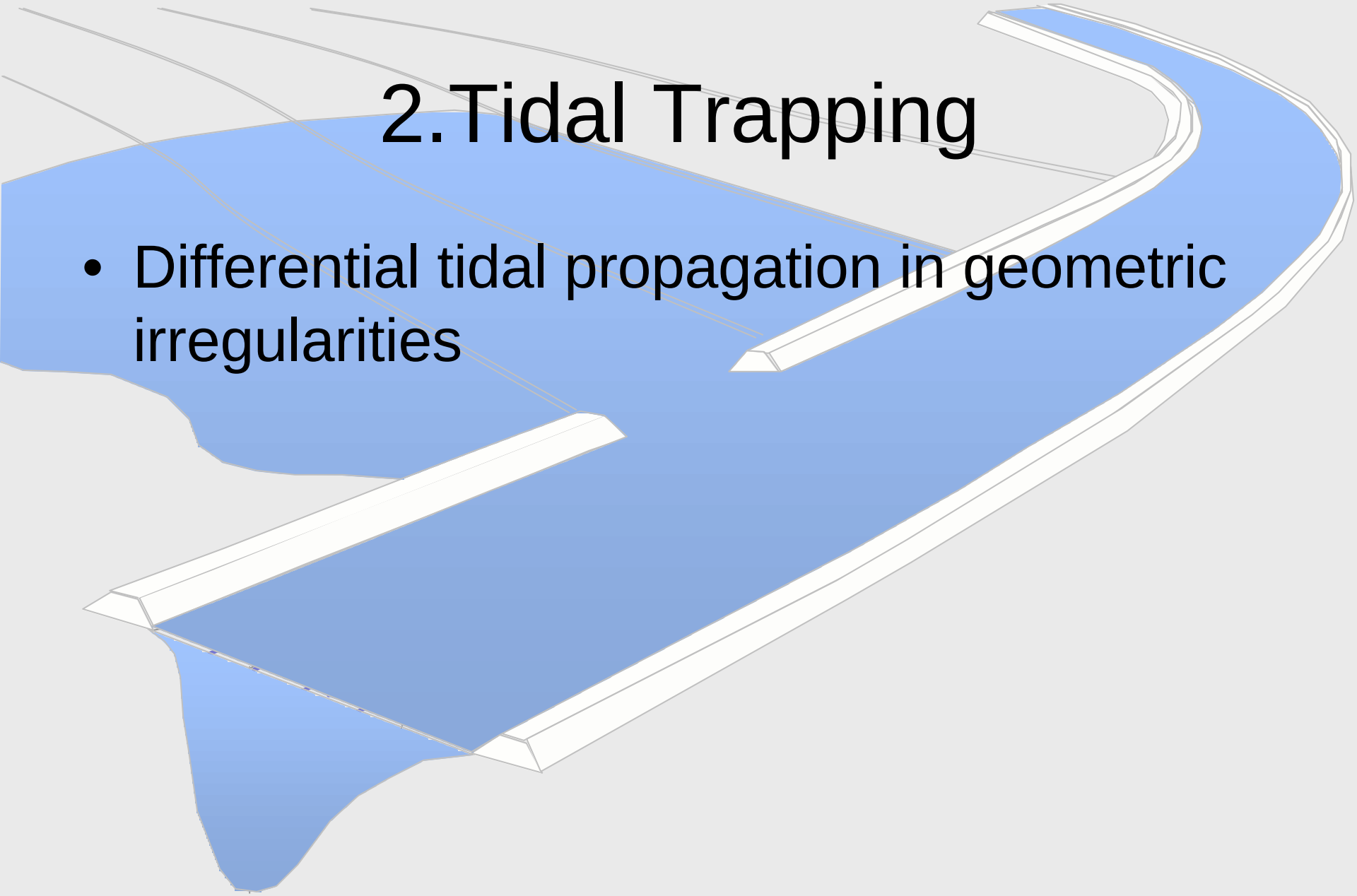
- Channel convergence

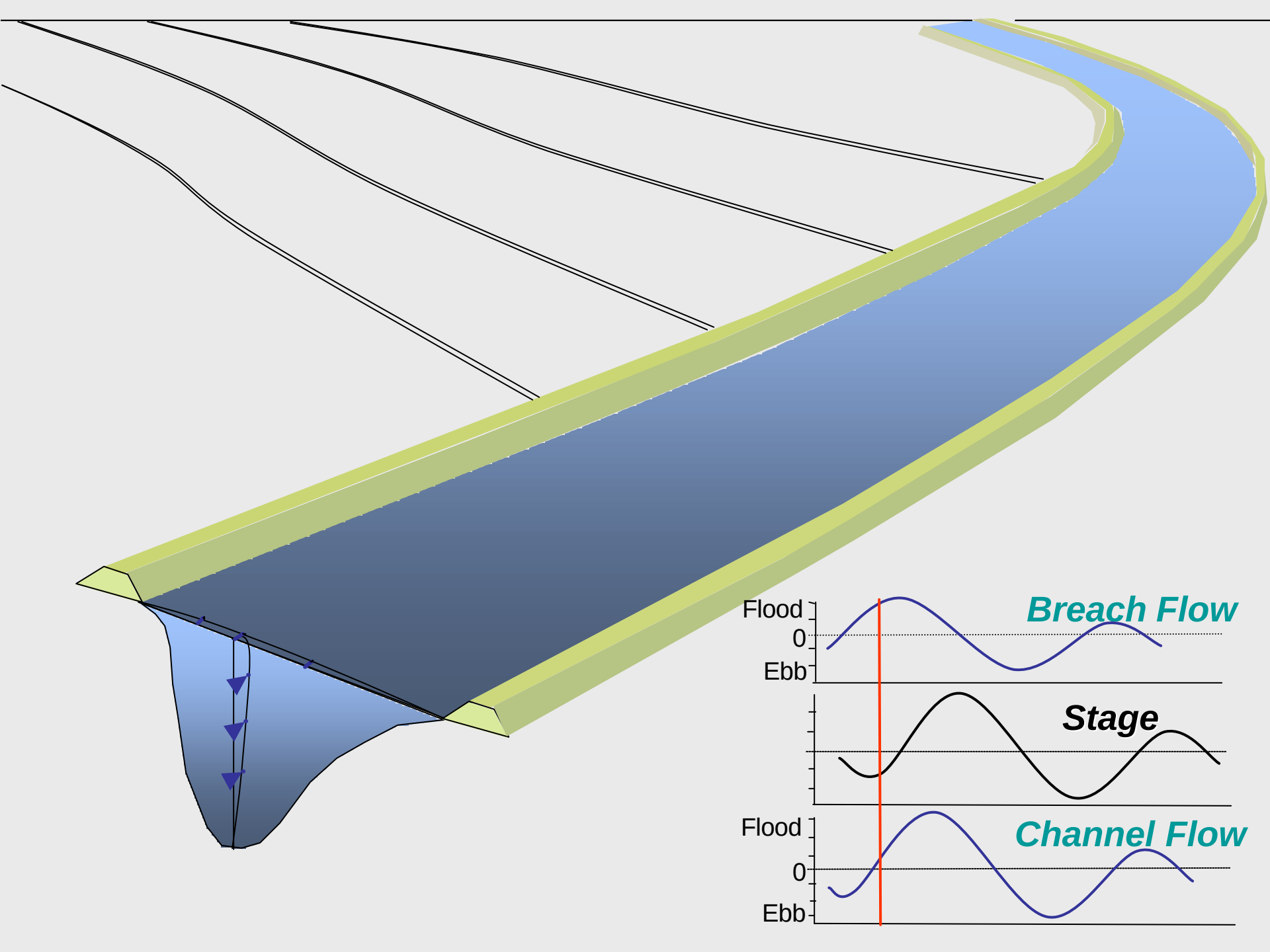
- Channel irregularities



2.Tidal Trapping

- Differential tidal propagation in geometric irregularities

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0
Ebb
Breach Flow
Stage
Flood
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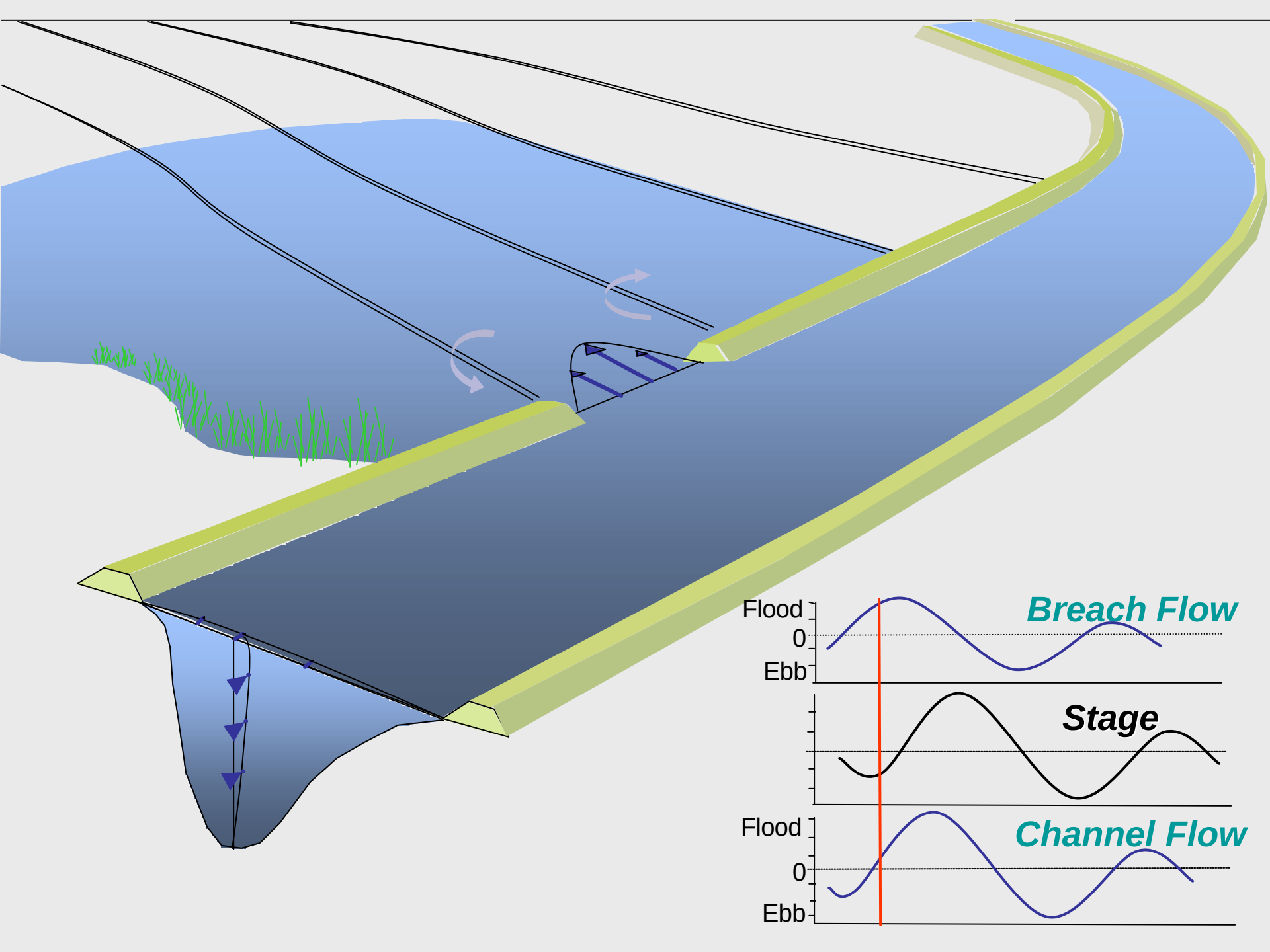
Ebb
Channel Flow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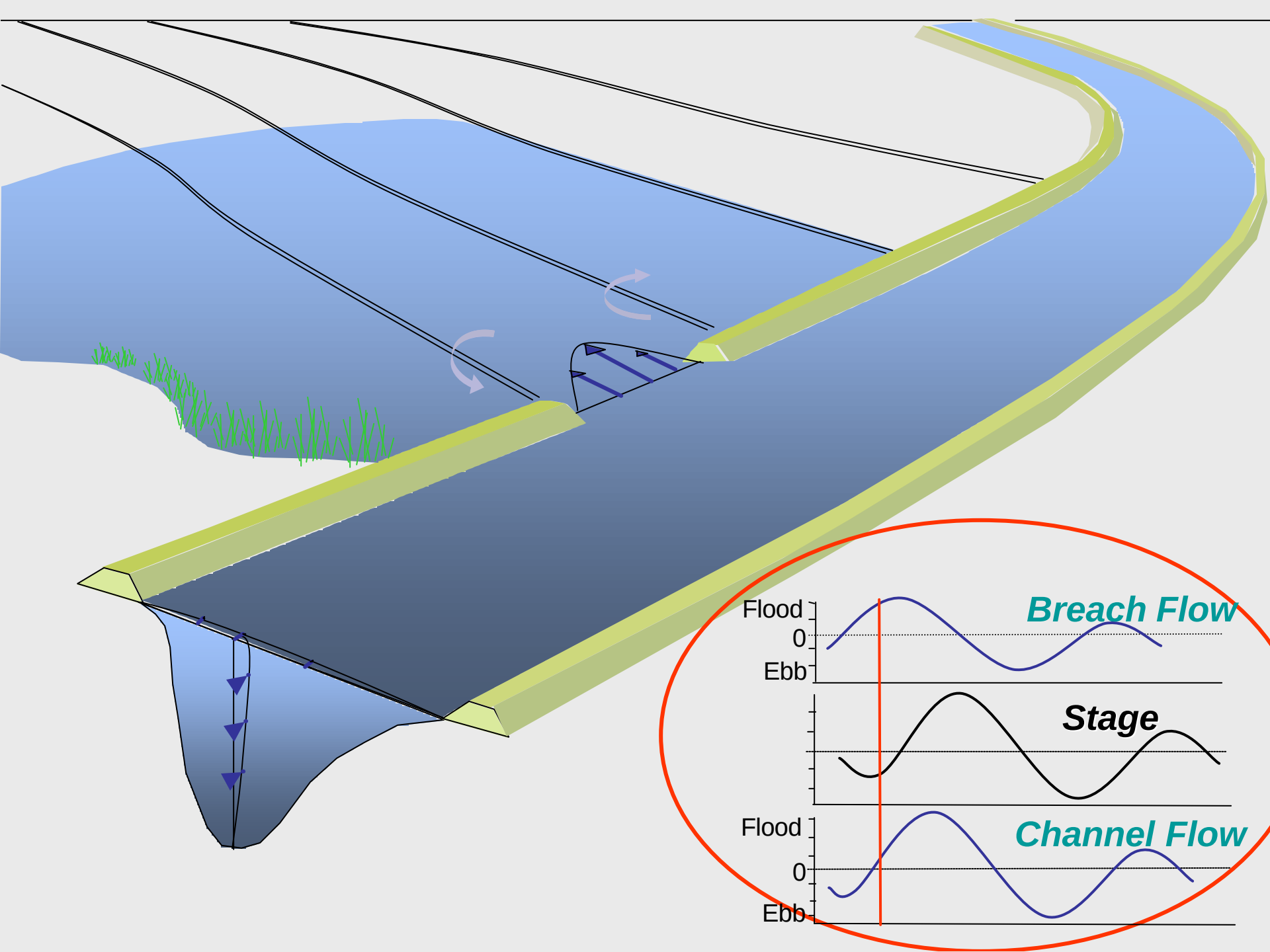
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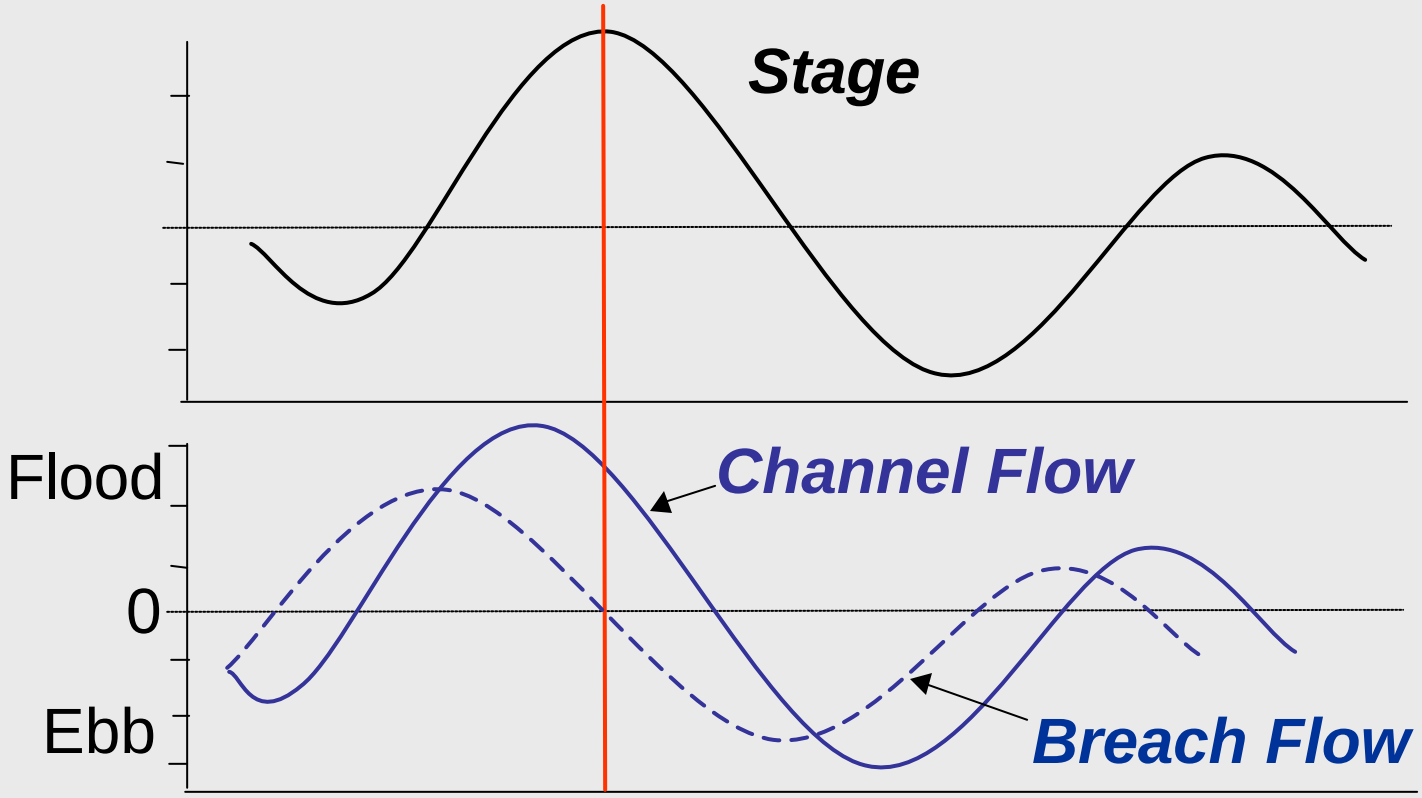
Tidal Trapping

- Timing of tidal stage and tidal flow:



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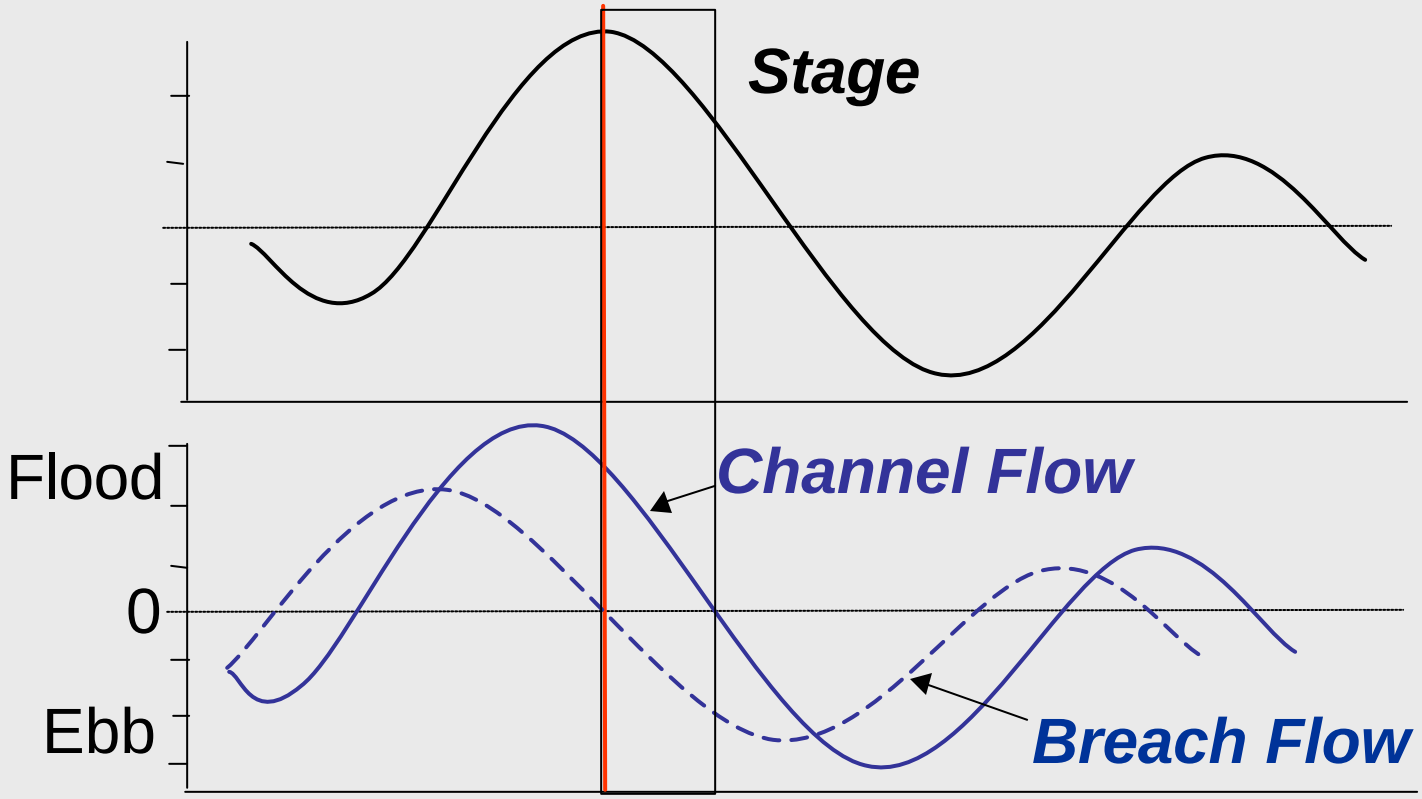
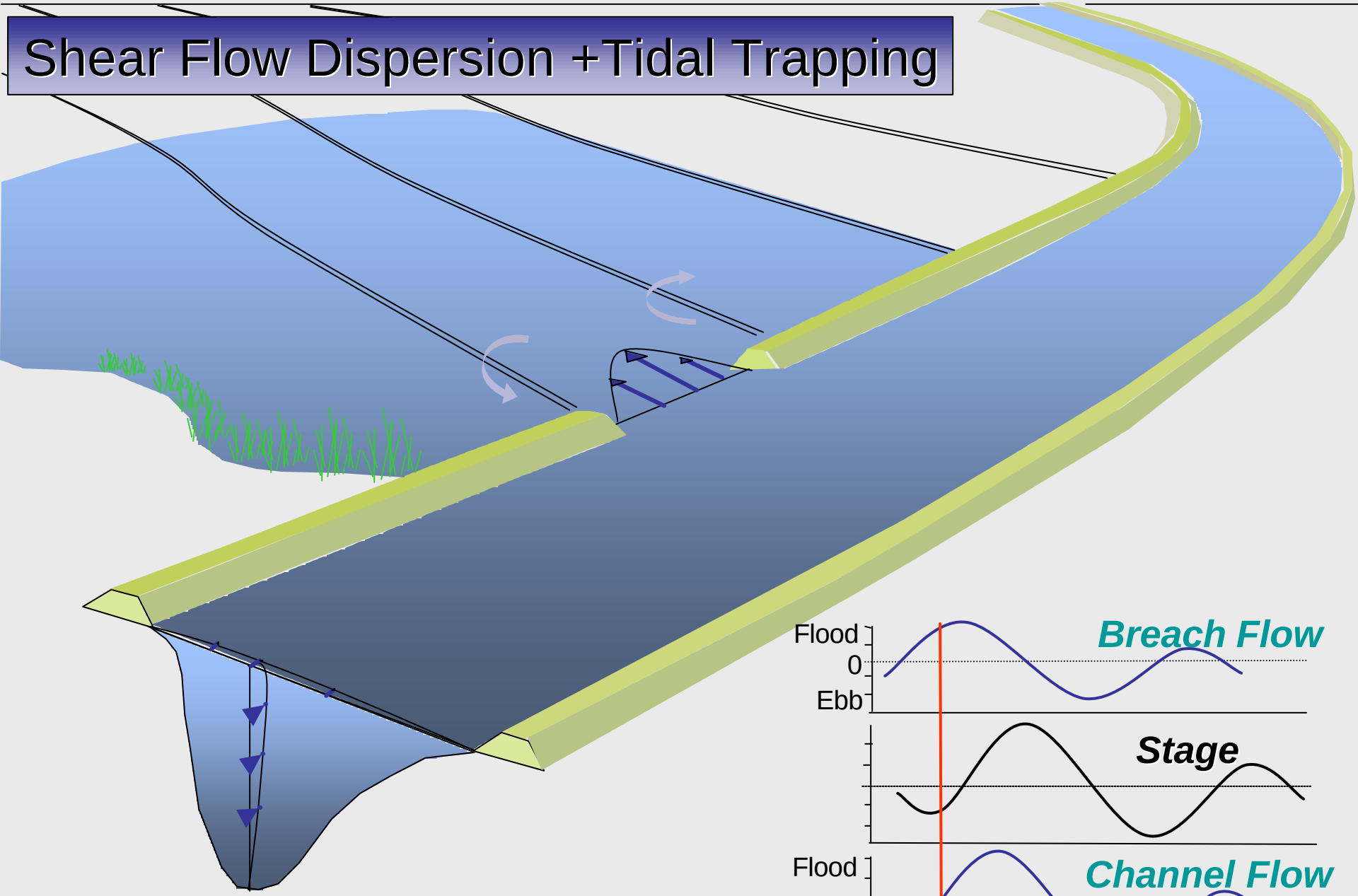


Shear Flow Dispersion +Tidal Trapping



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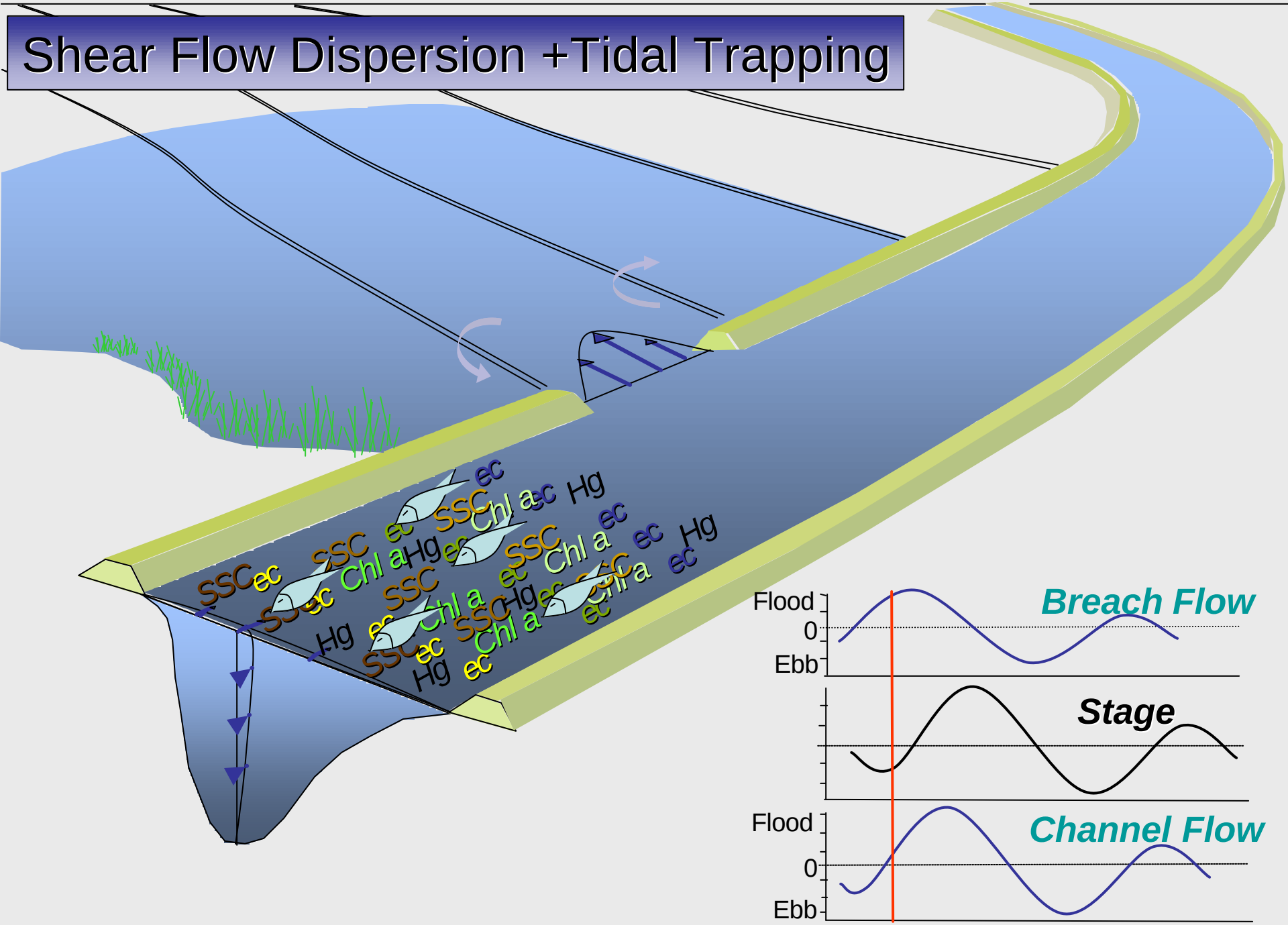

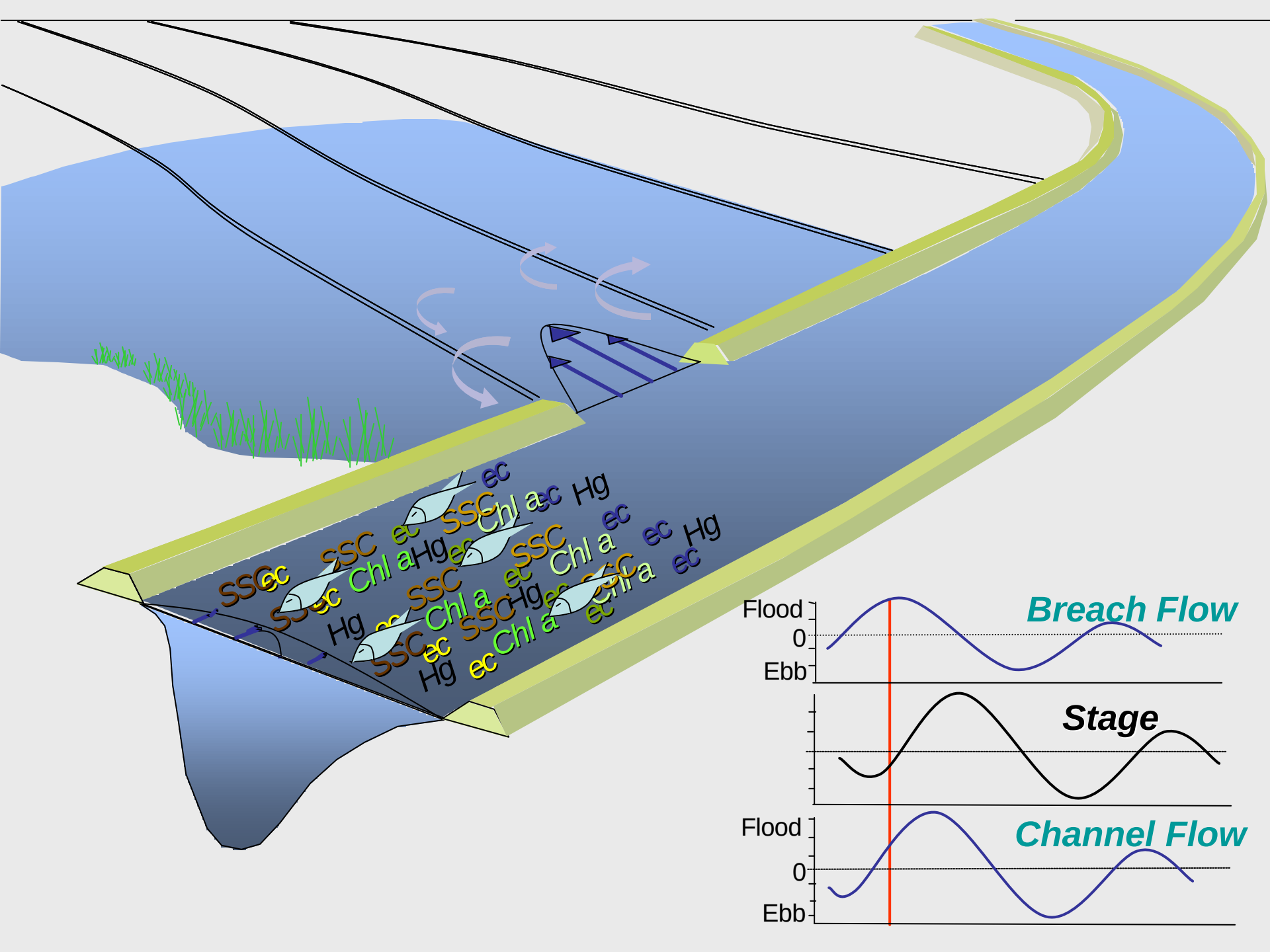
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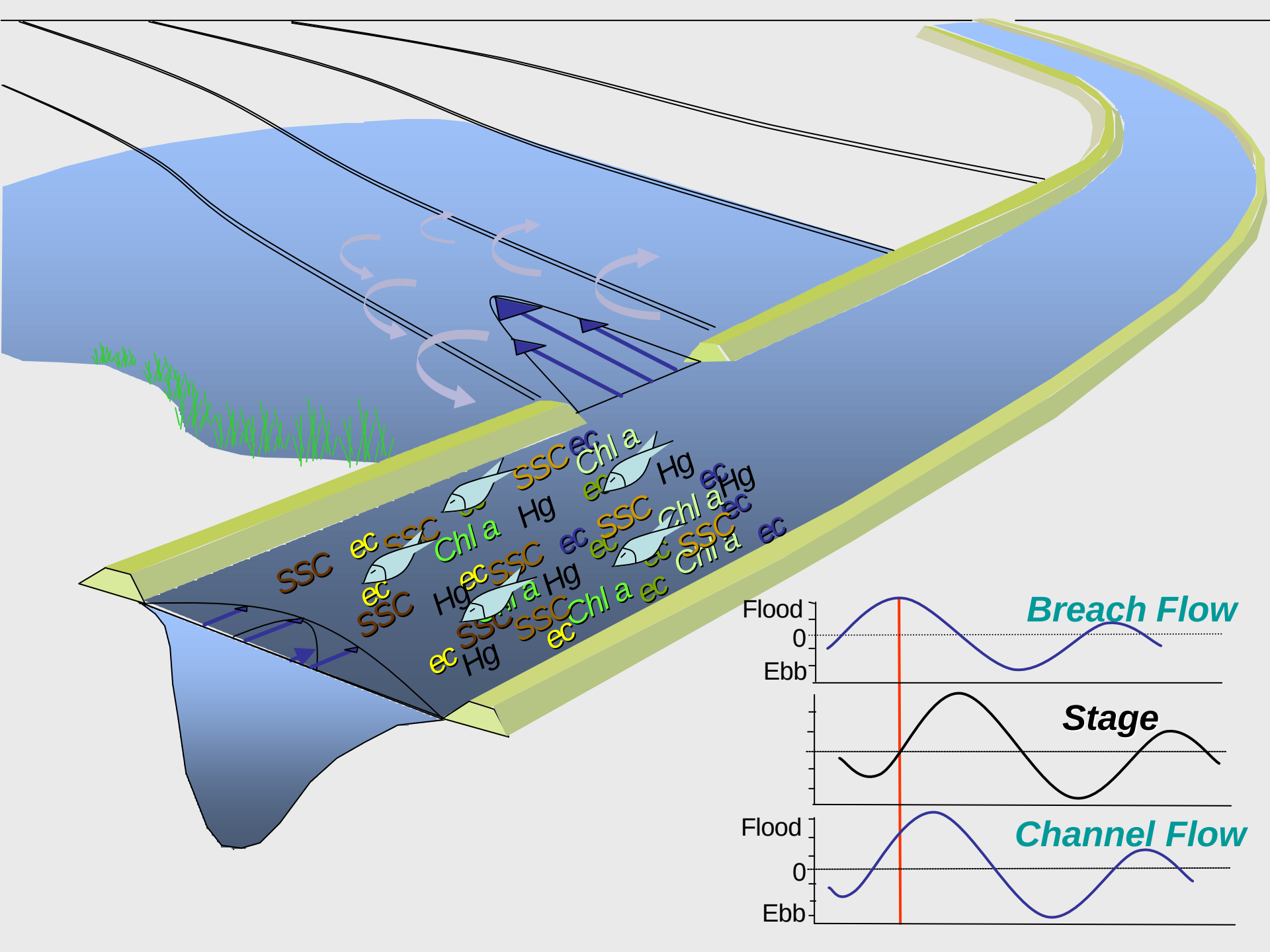
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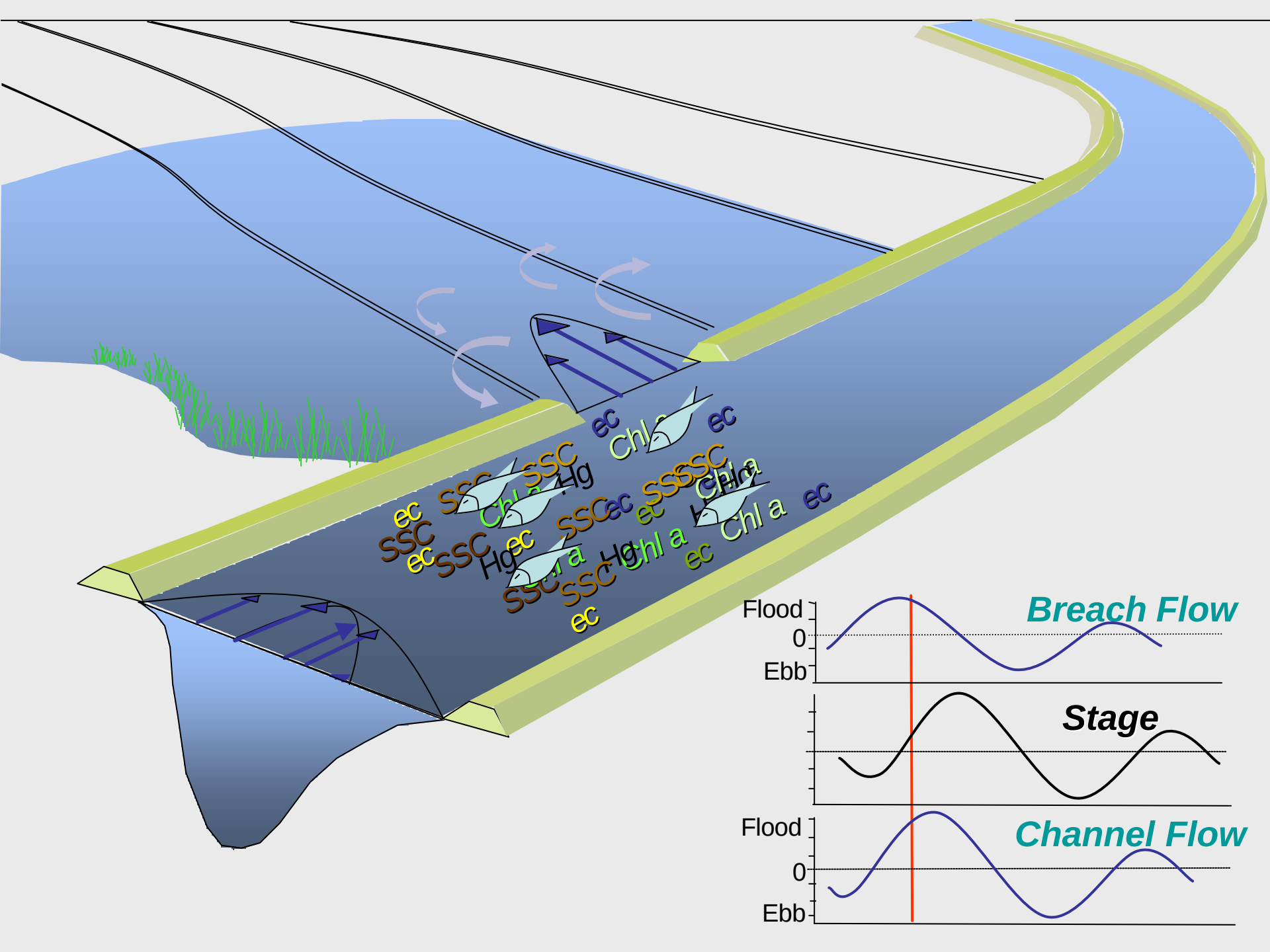
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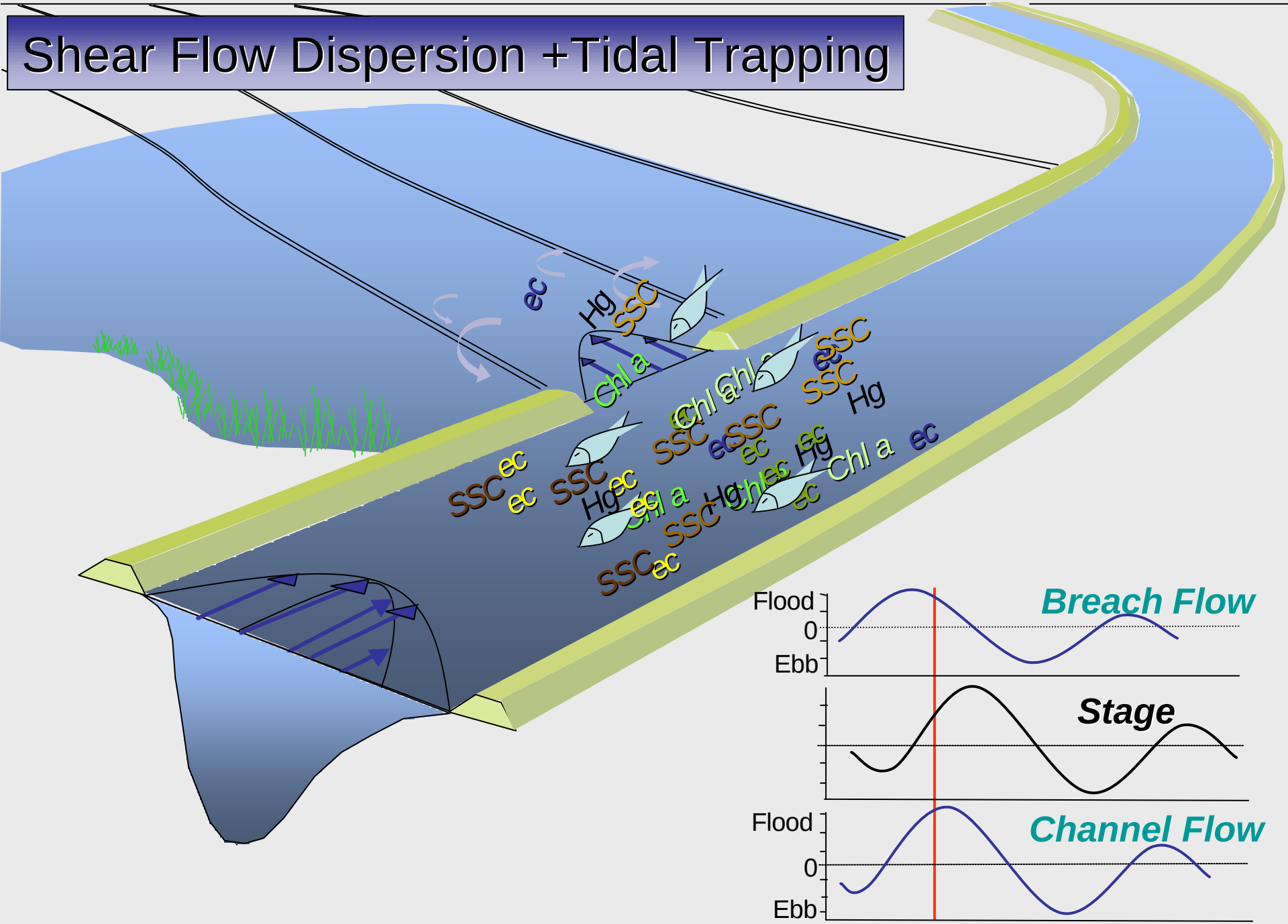
Shear Flow Dispersion +Tidal Trapping



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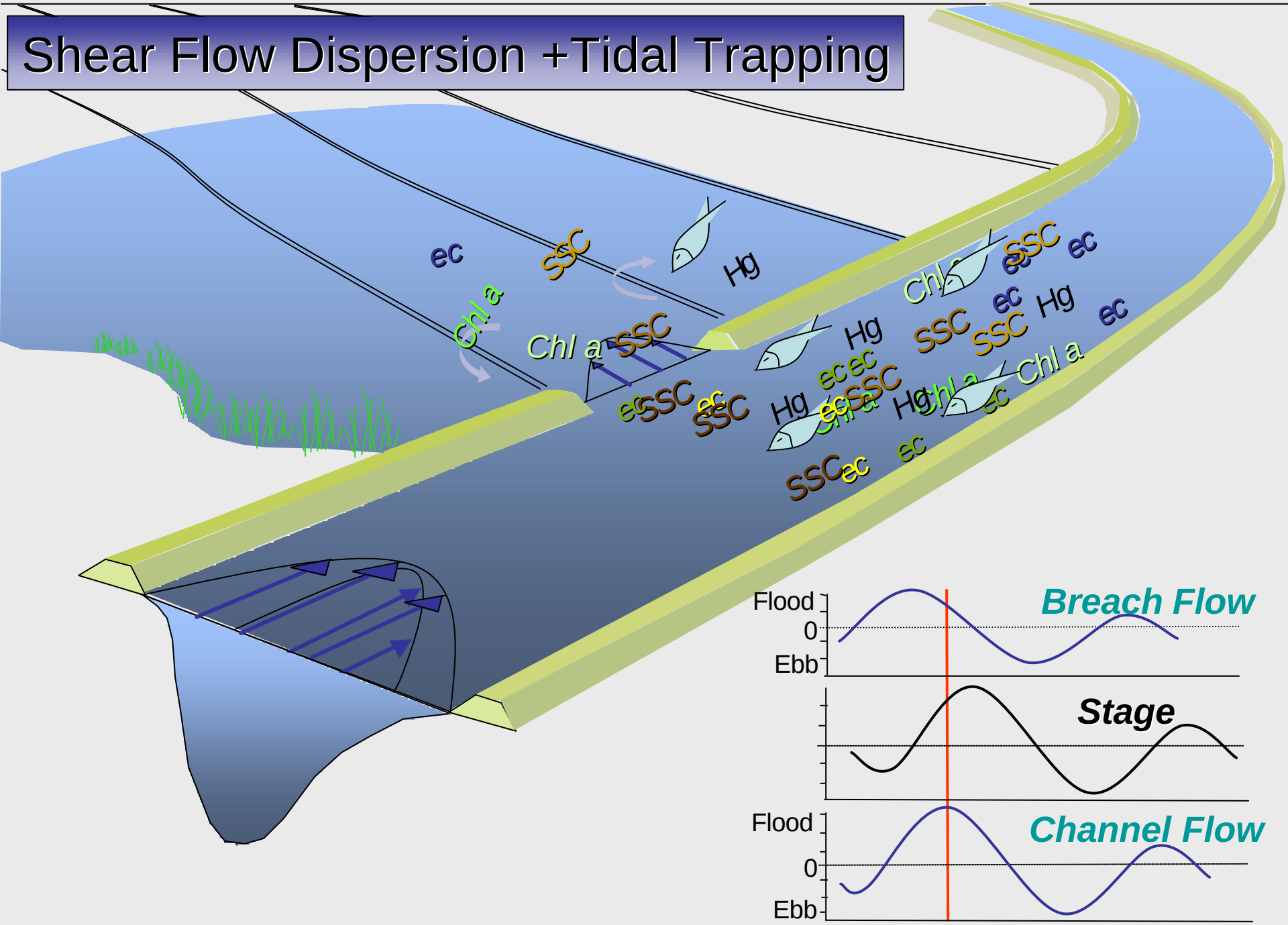

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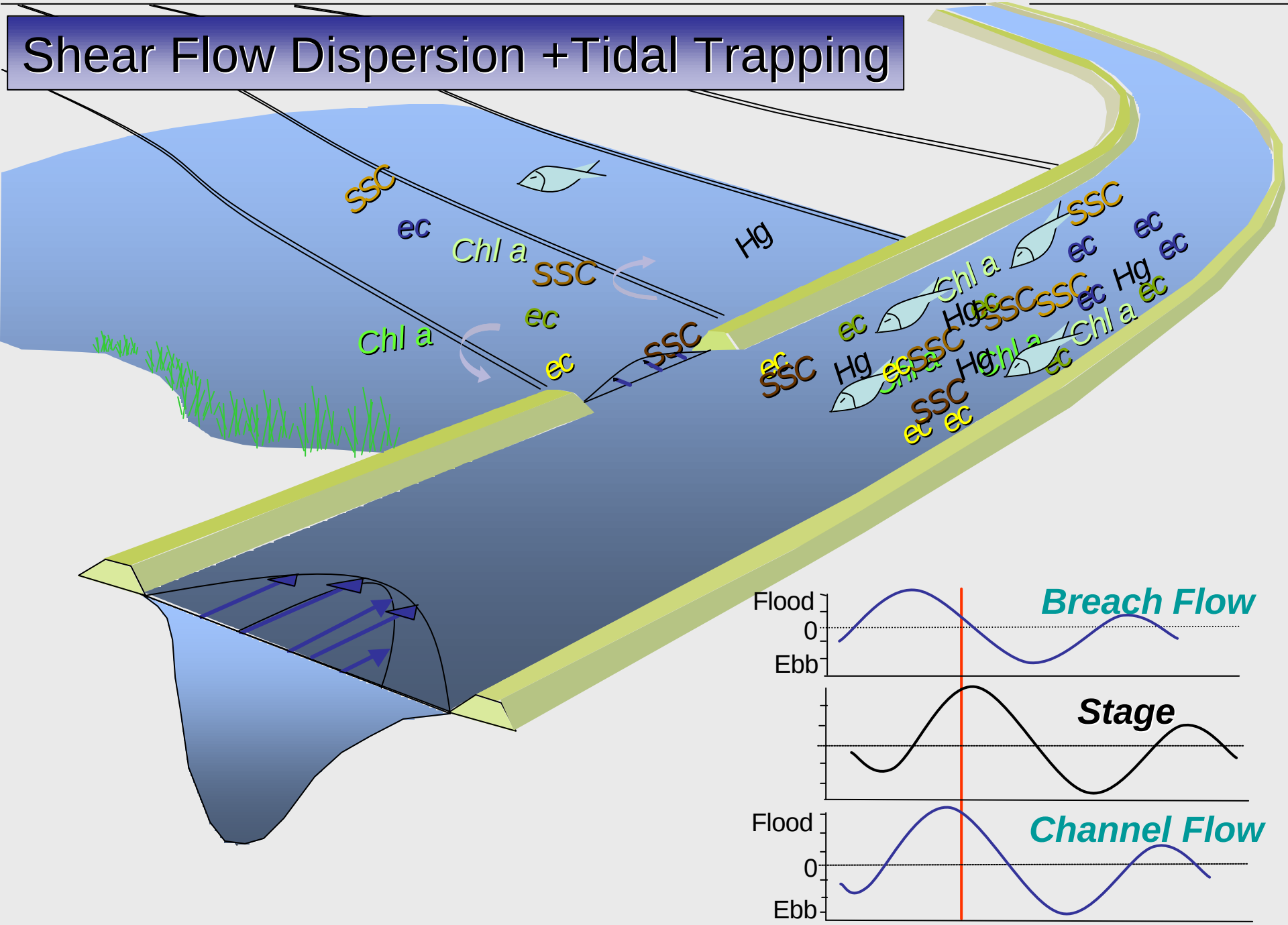

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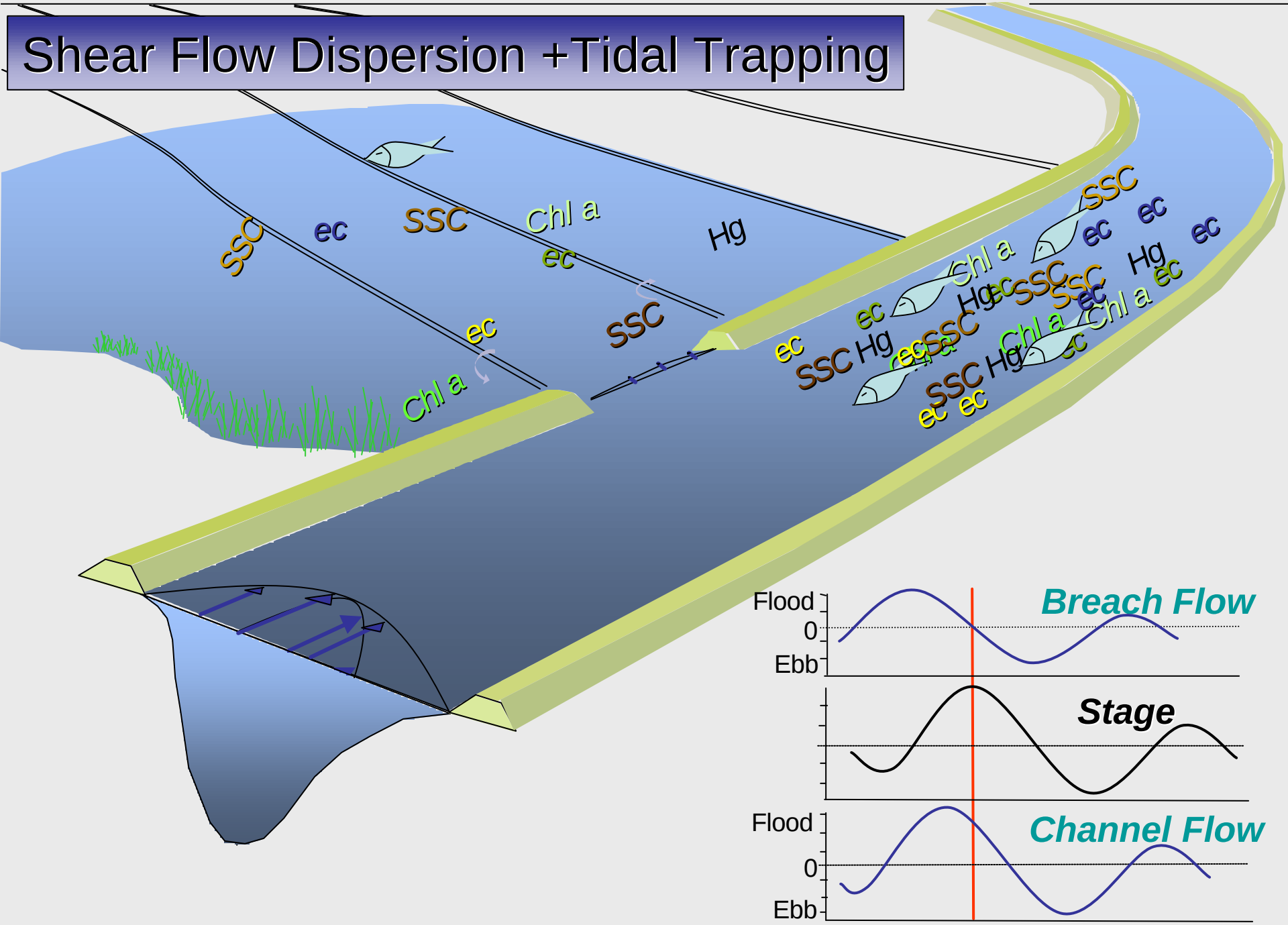

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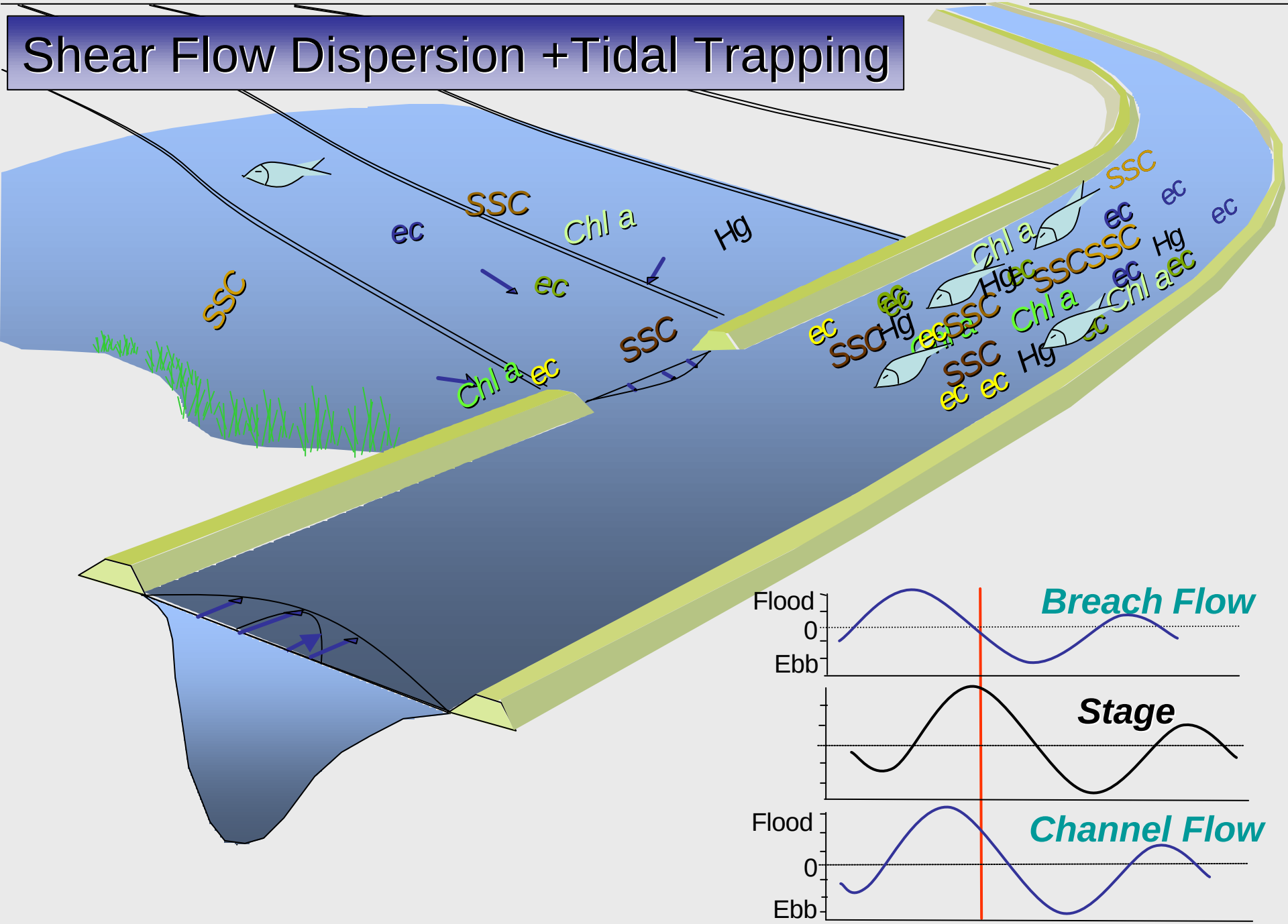

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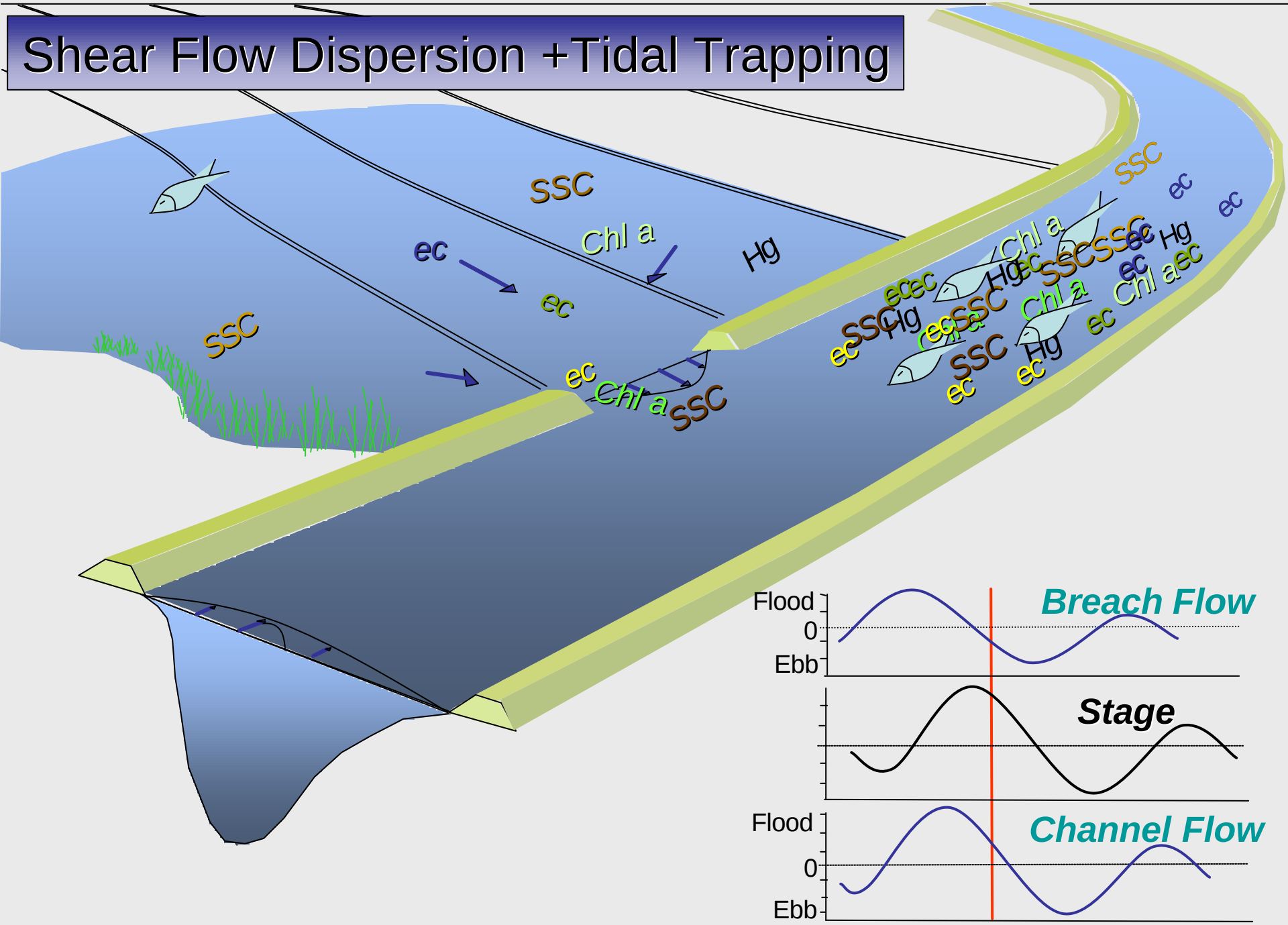

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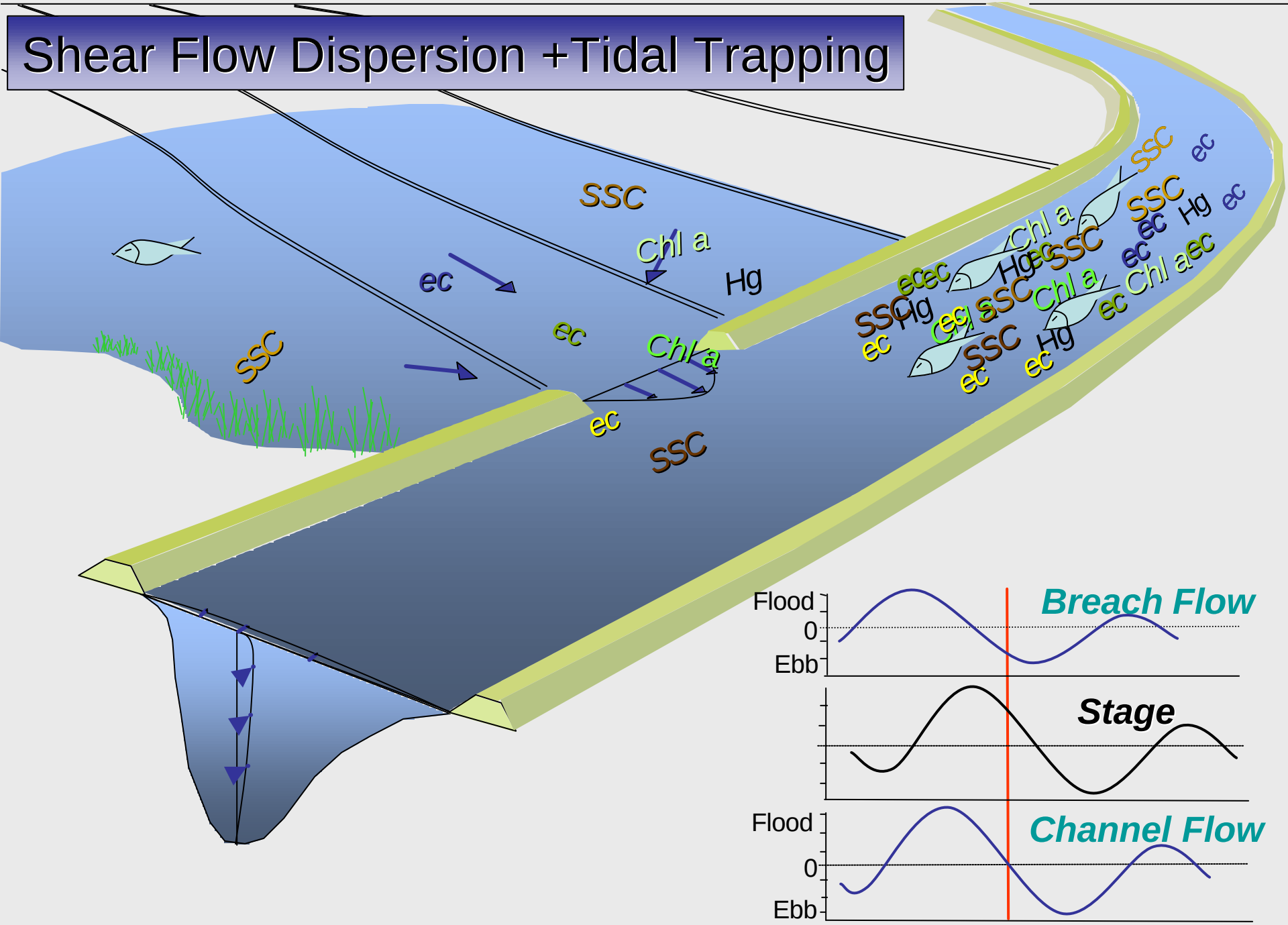

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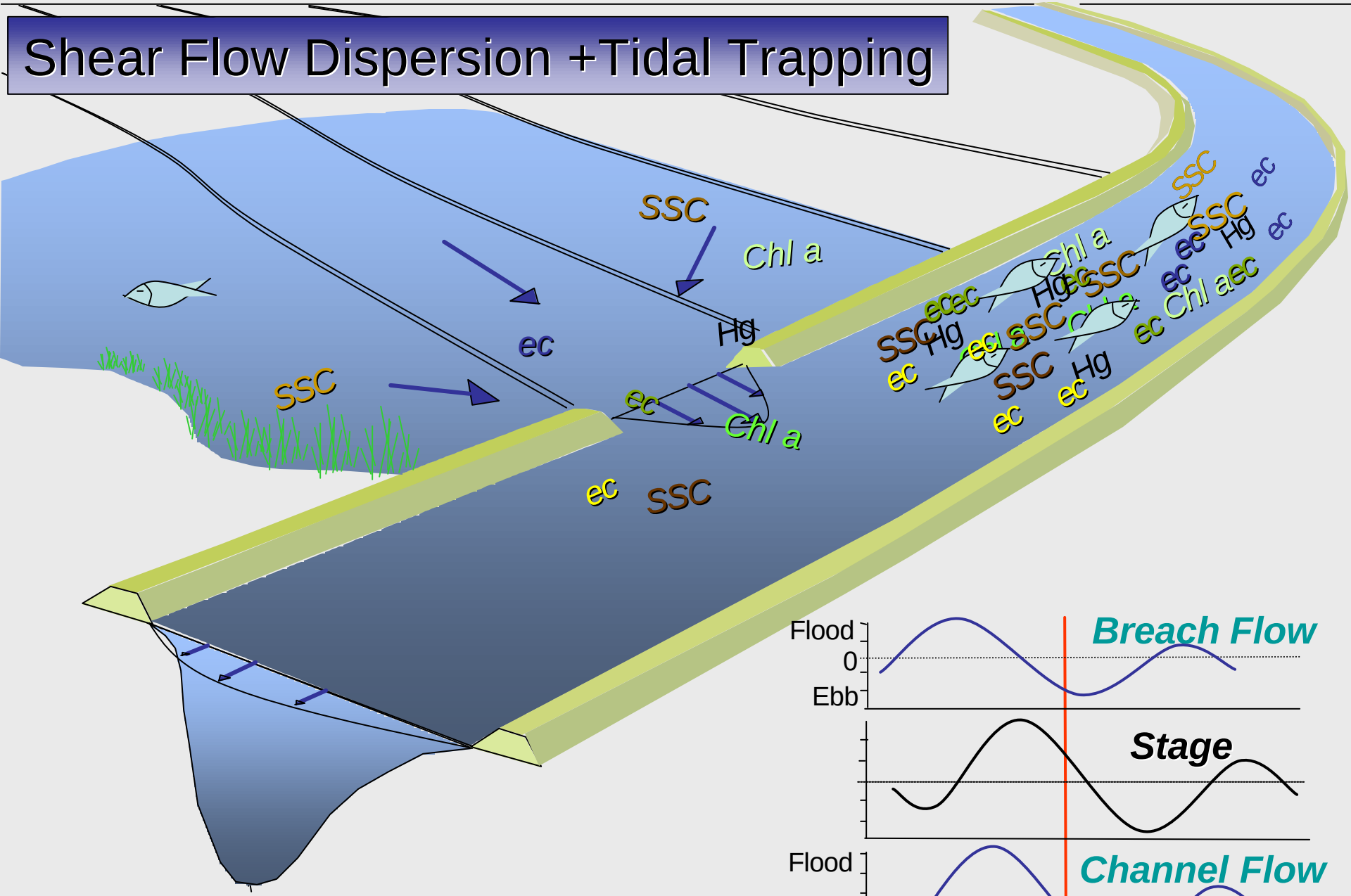

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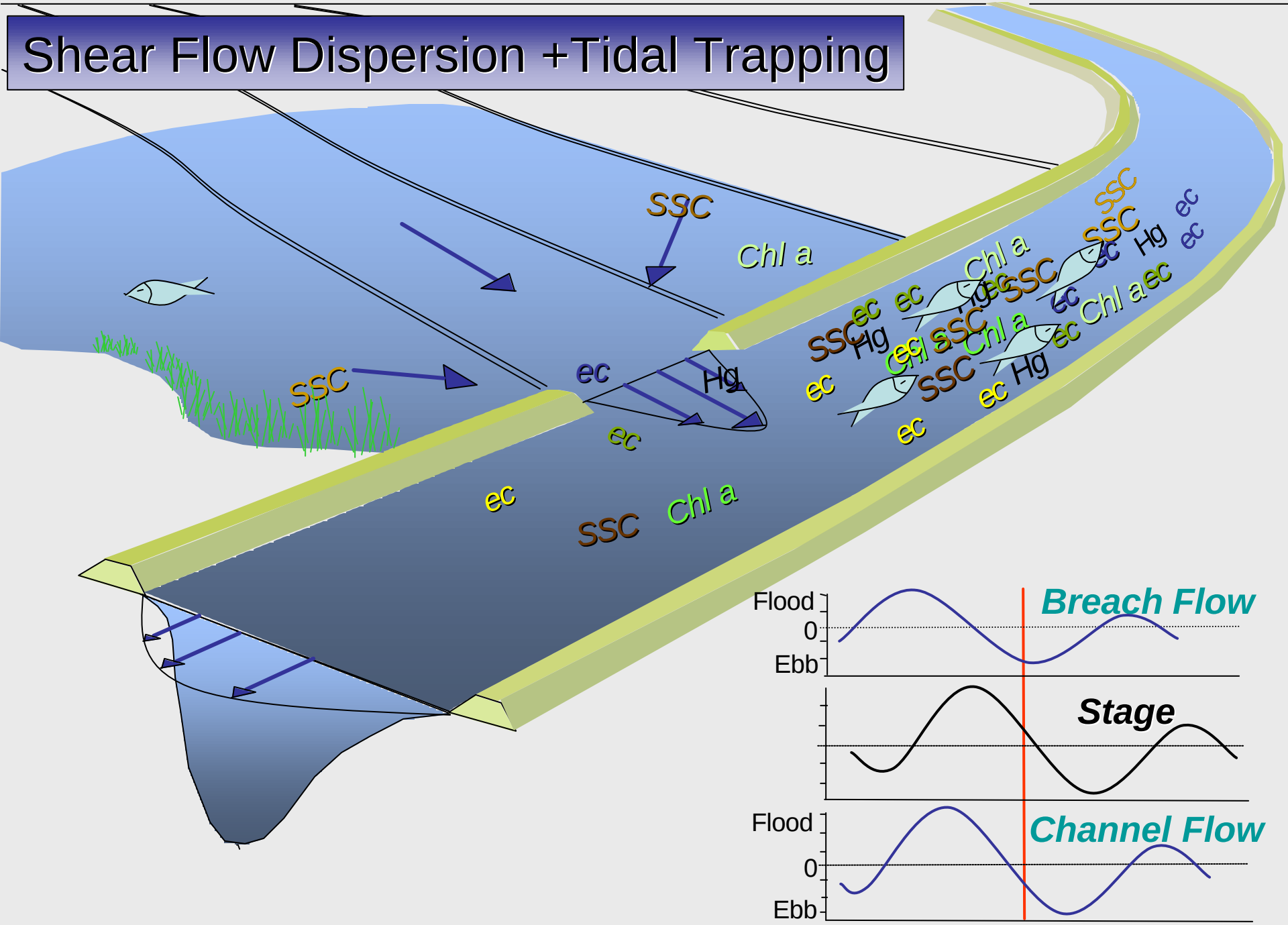

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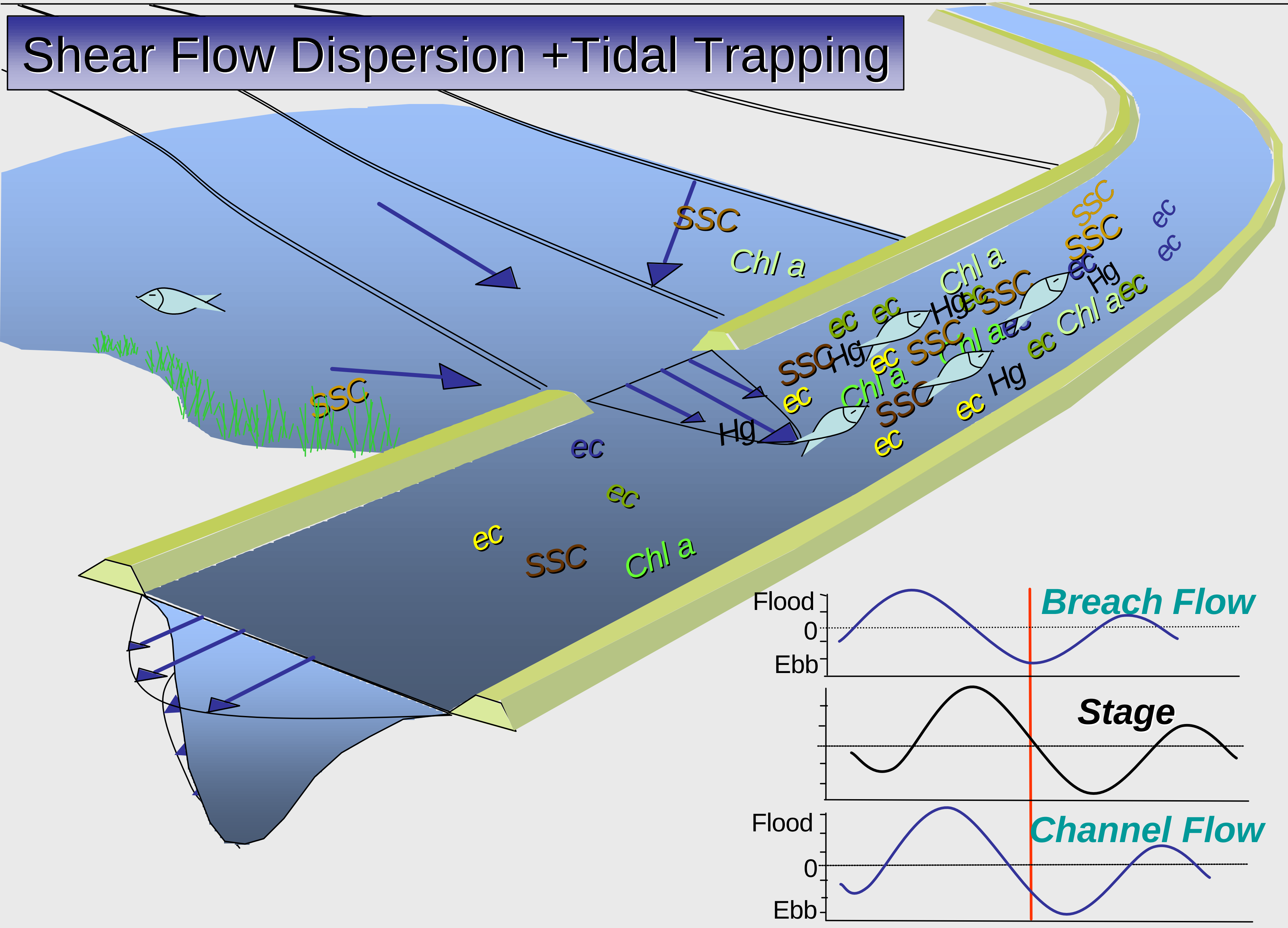

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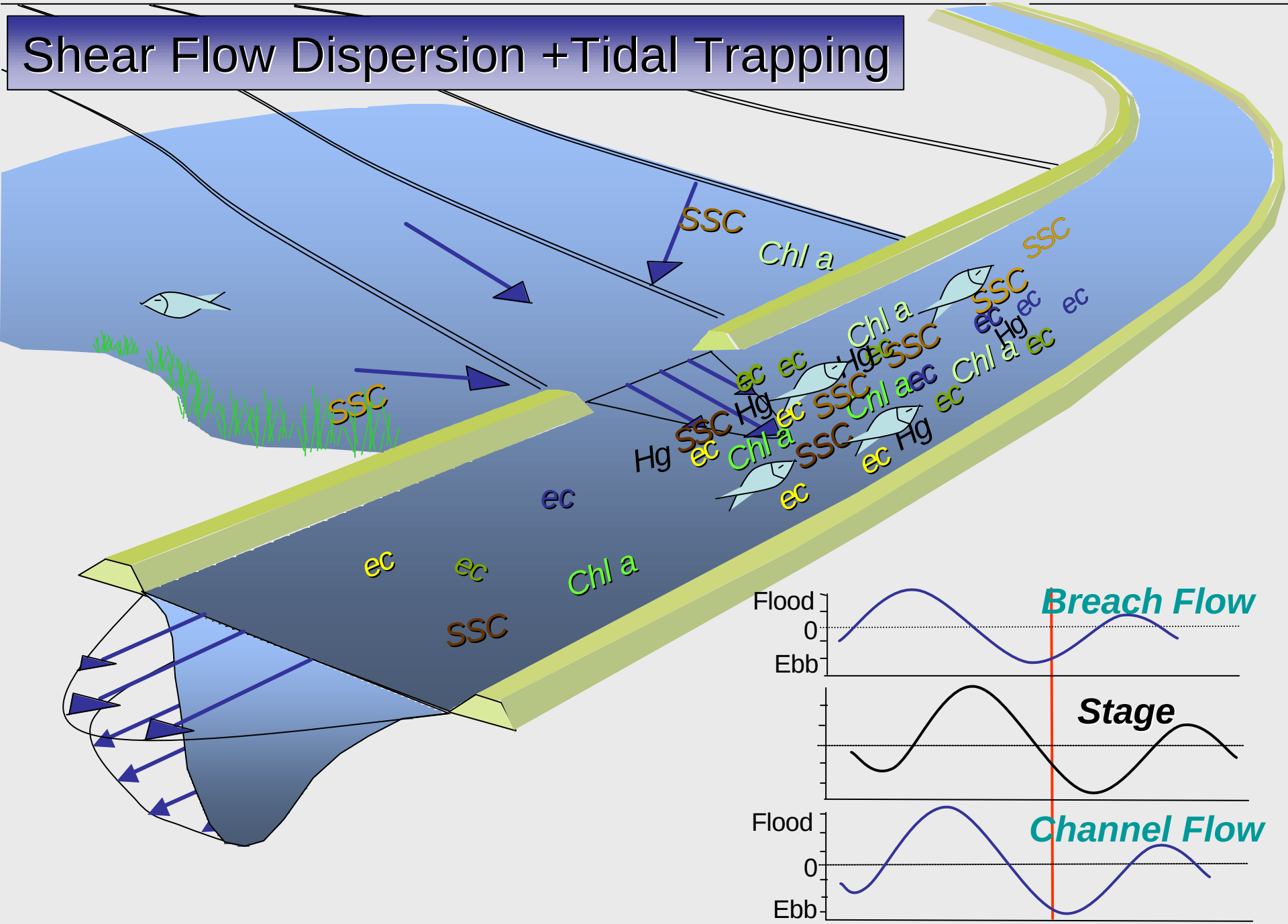

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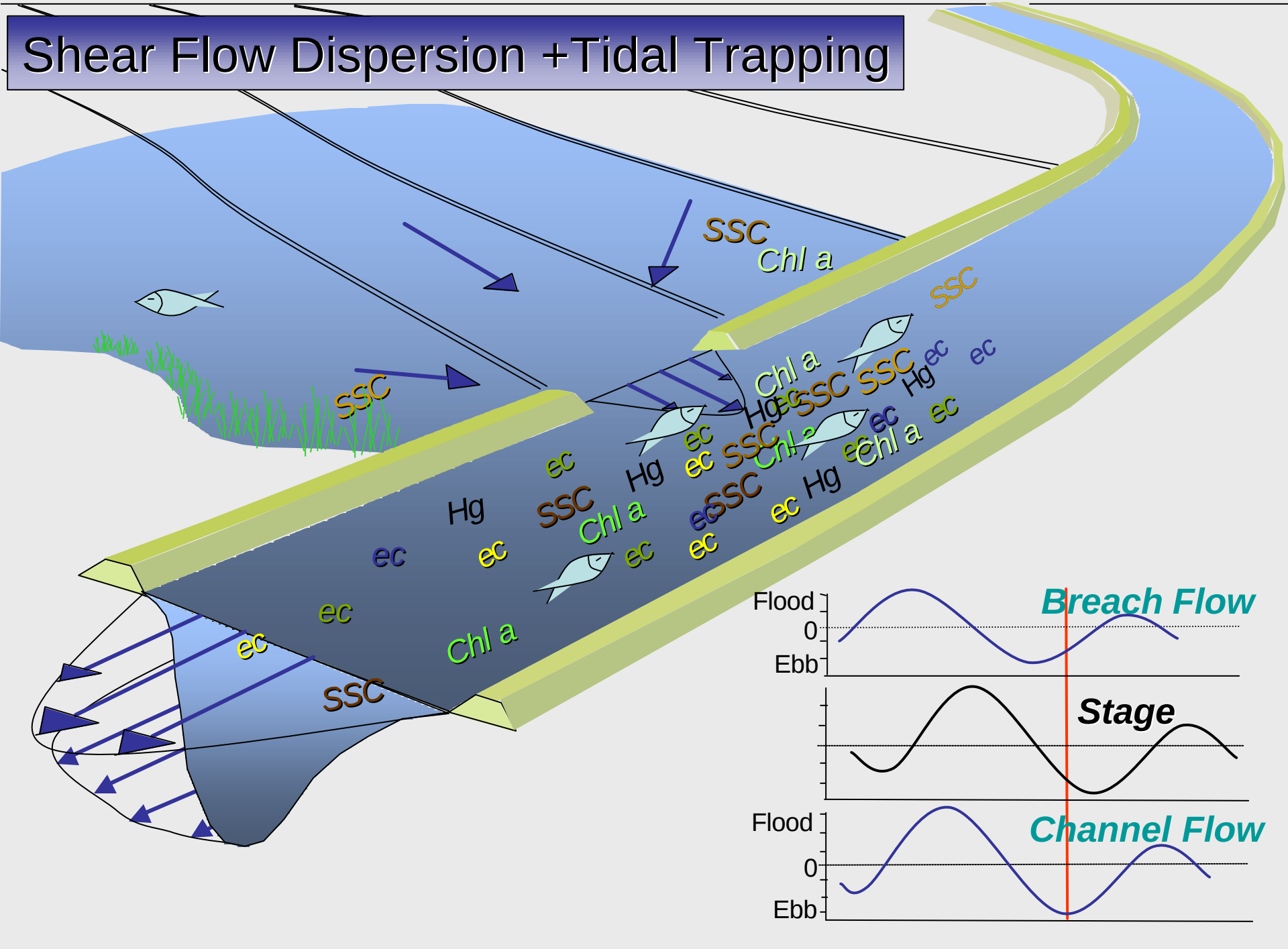

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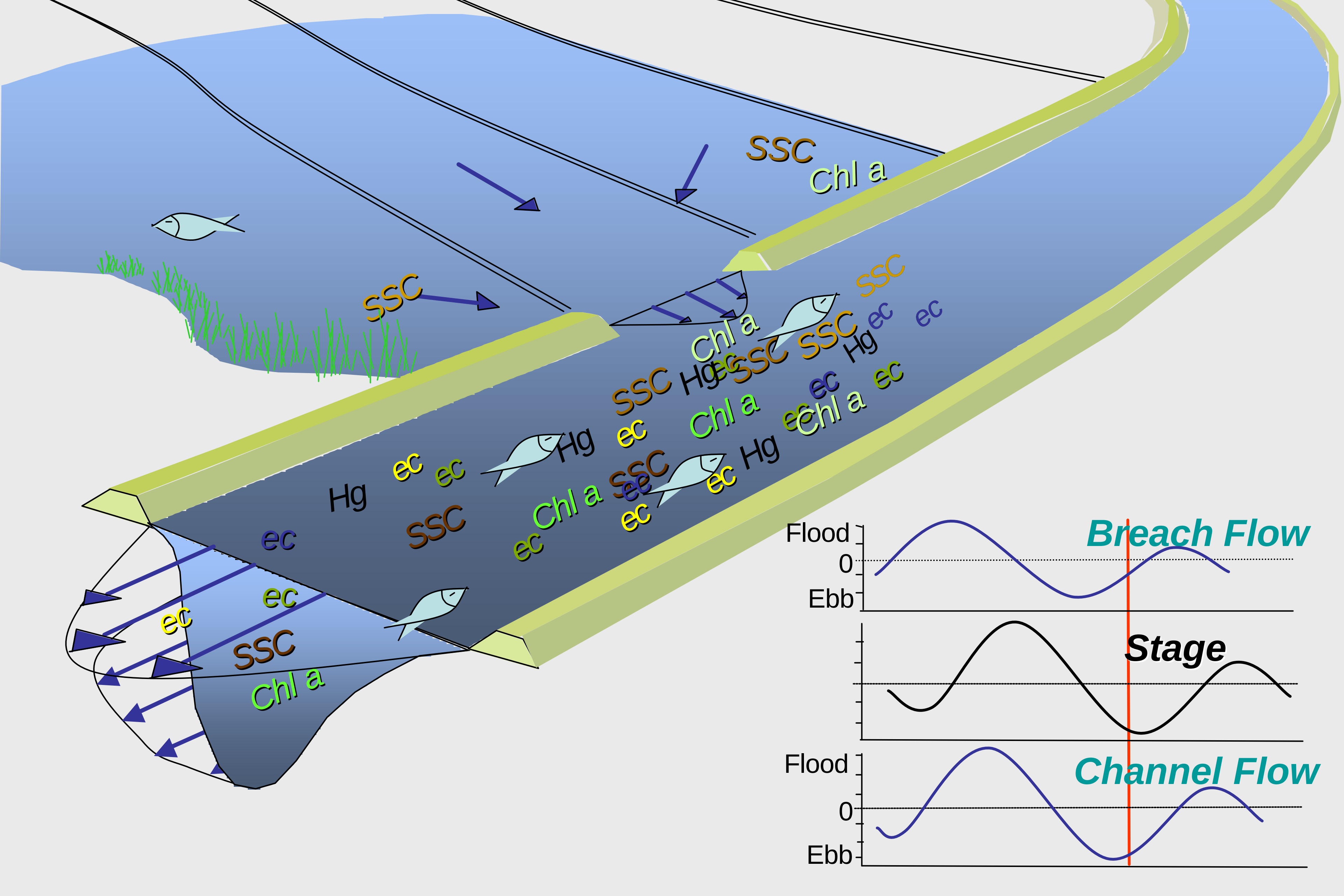

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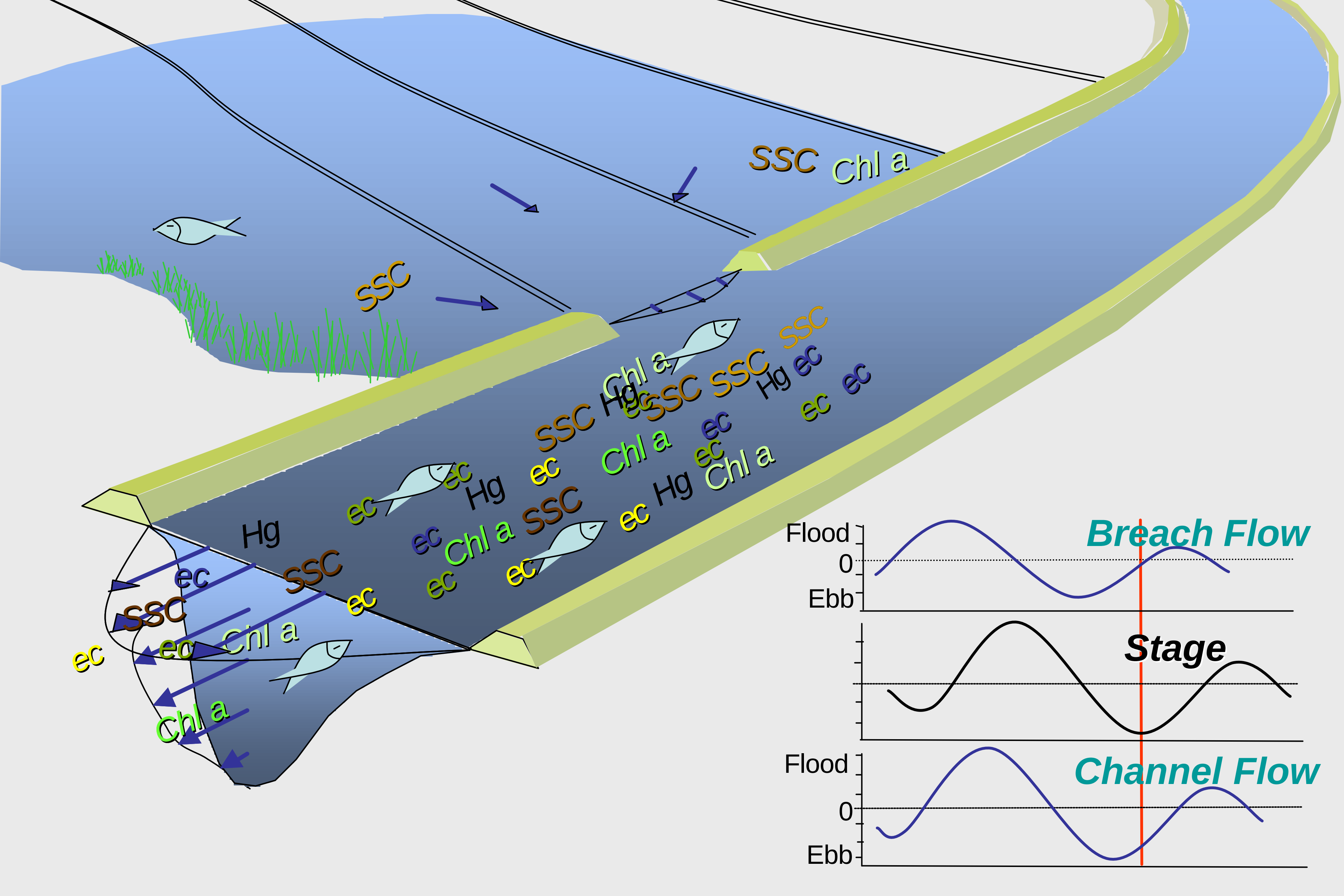

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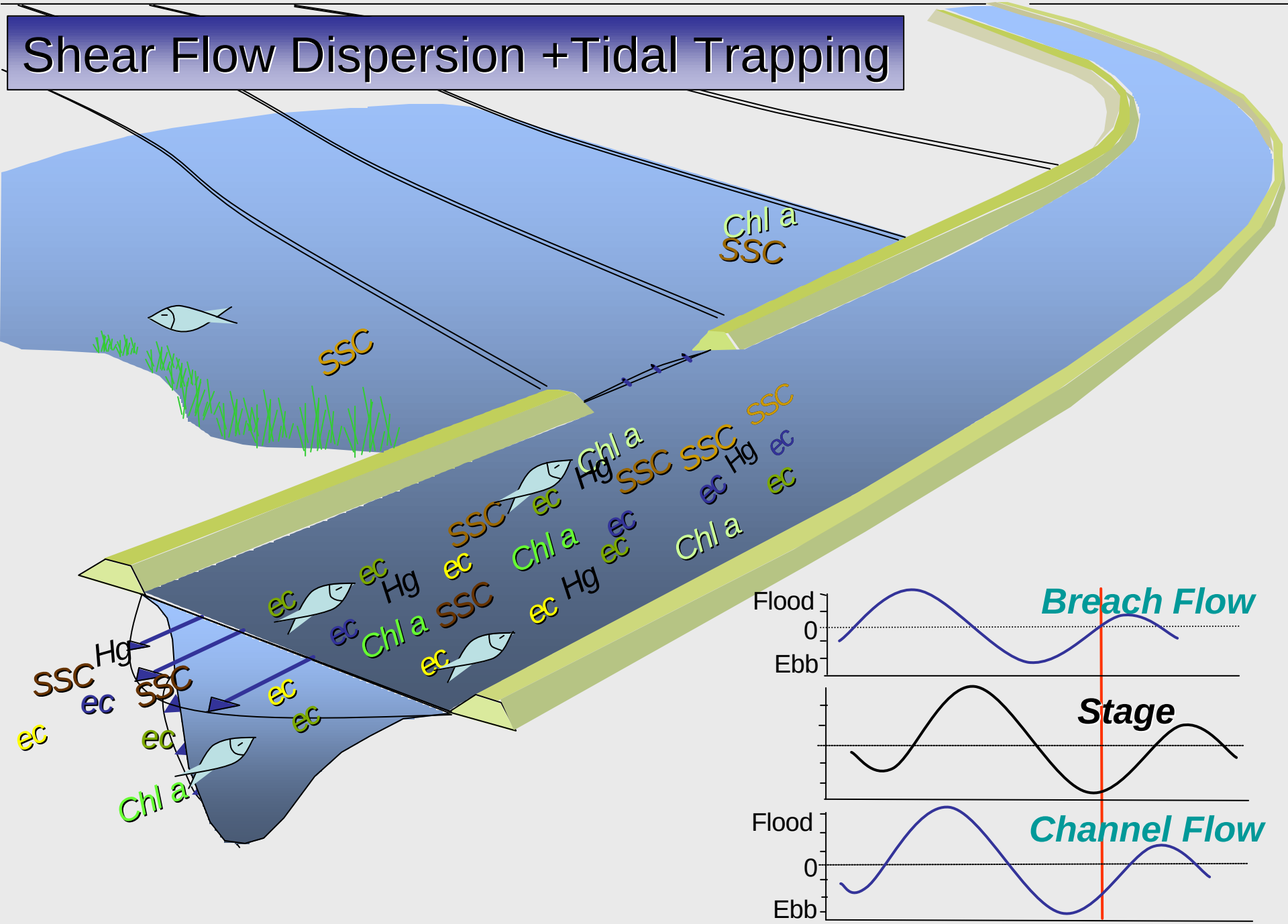

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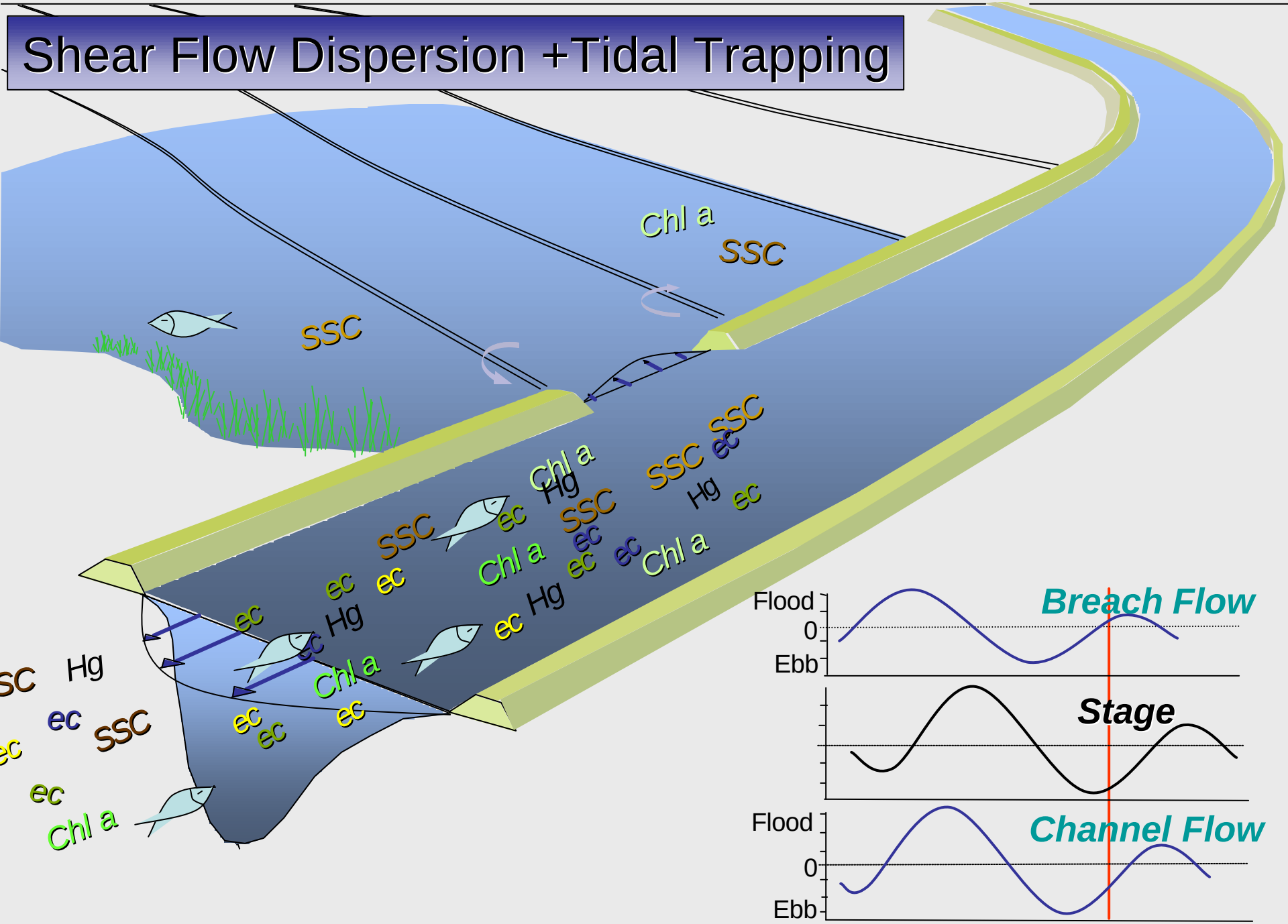

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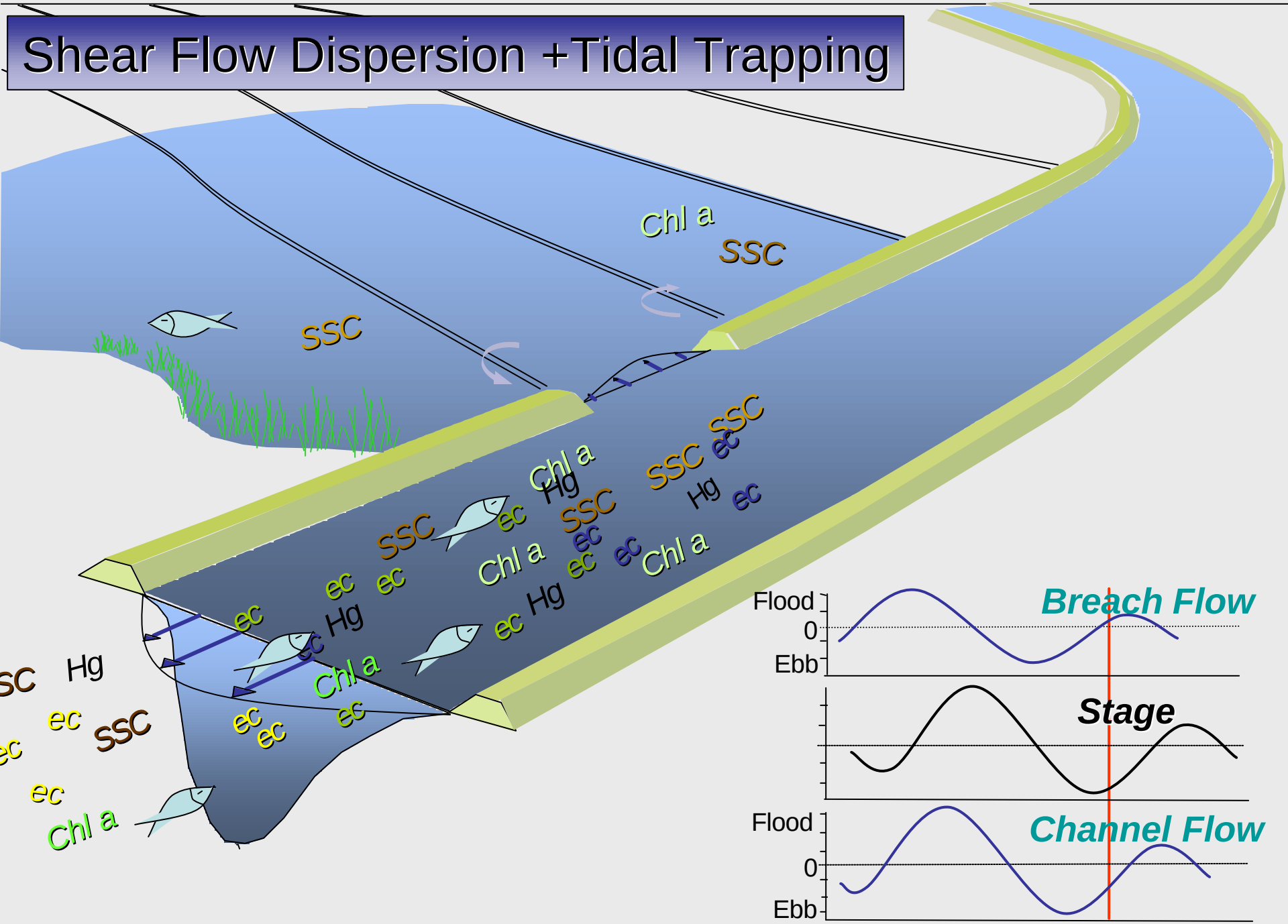

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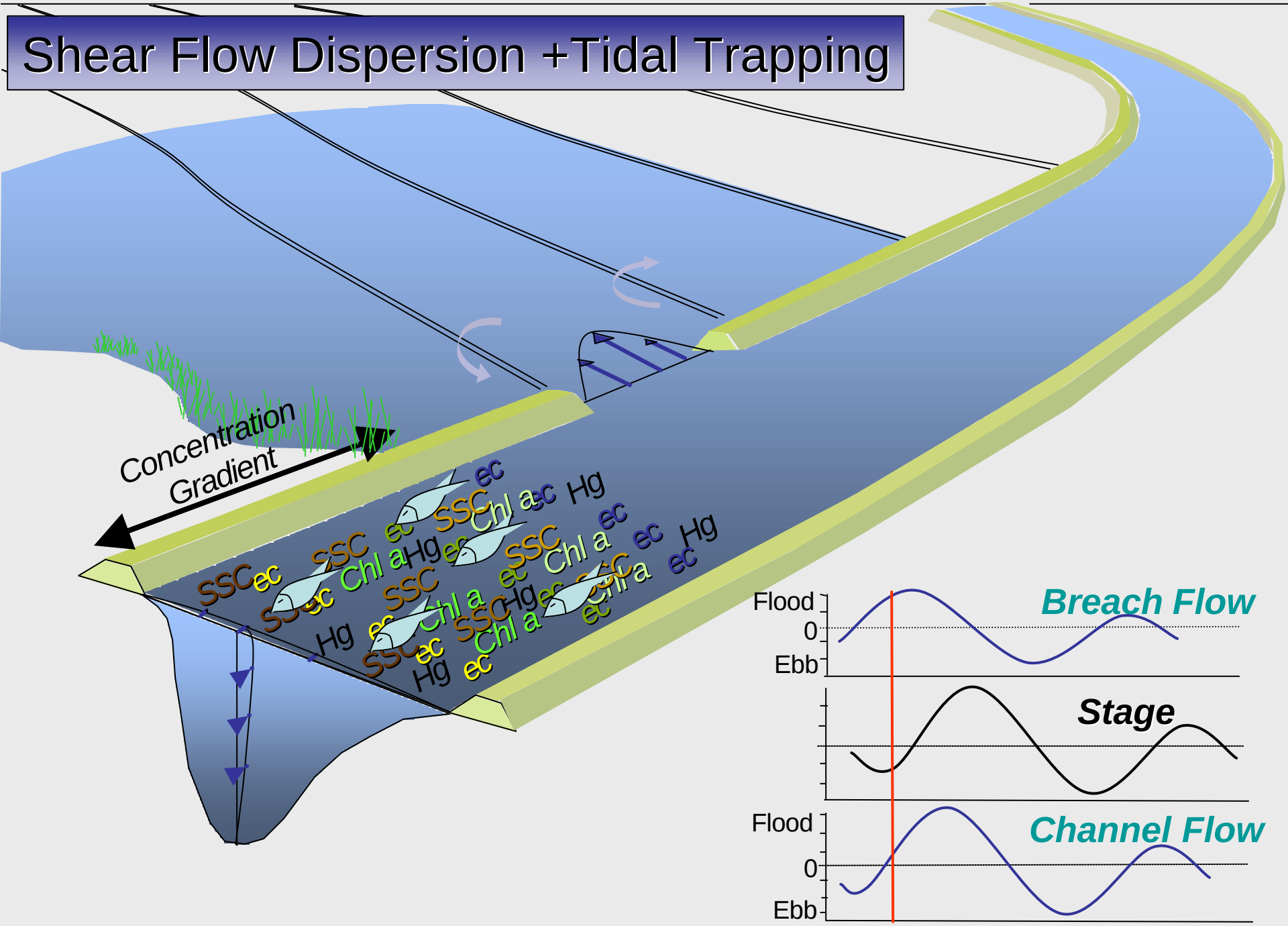

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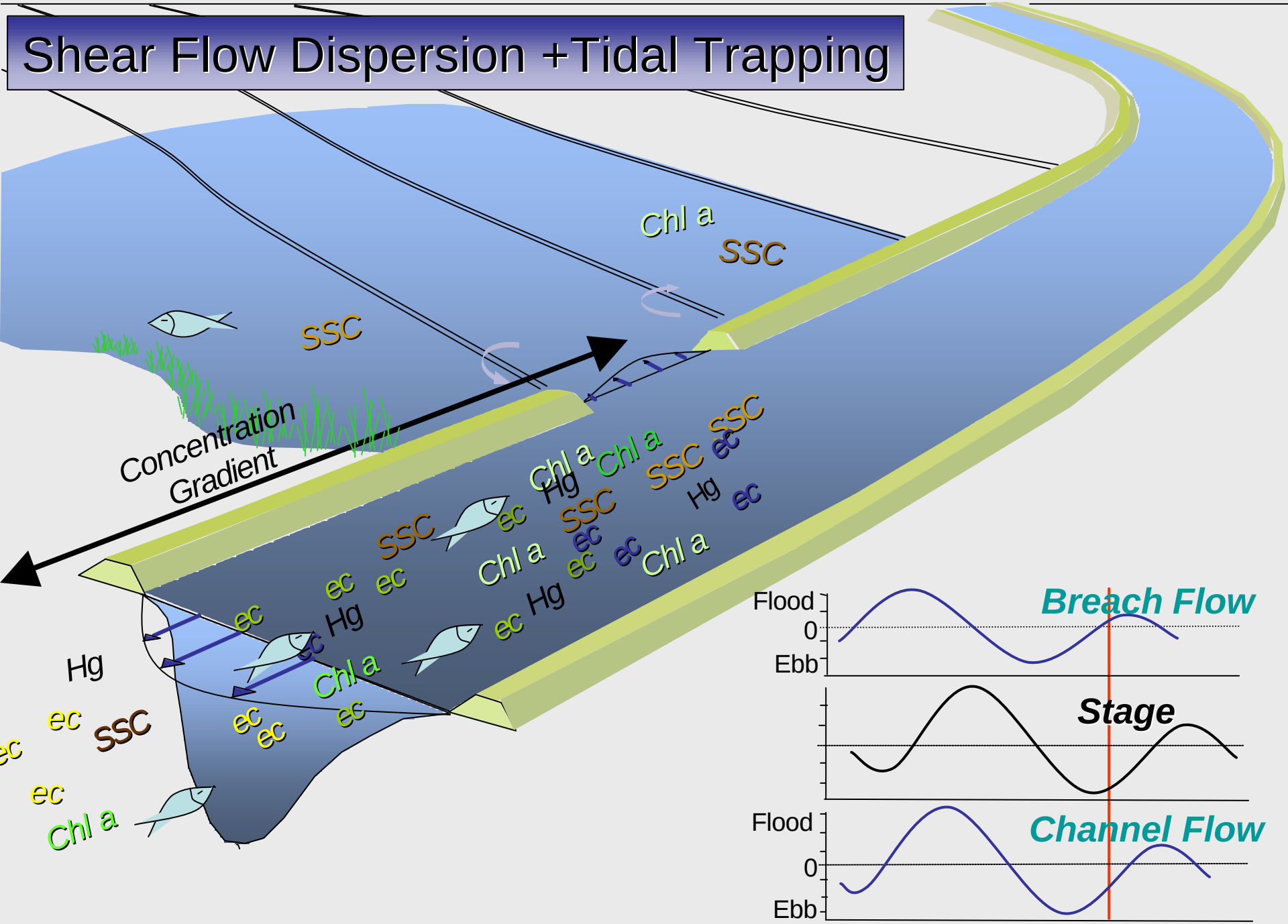

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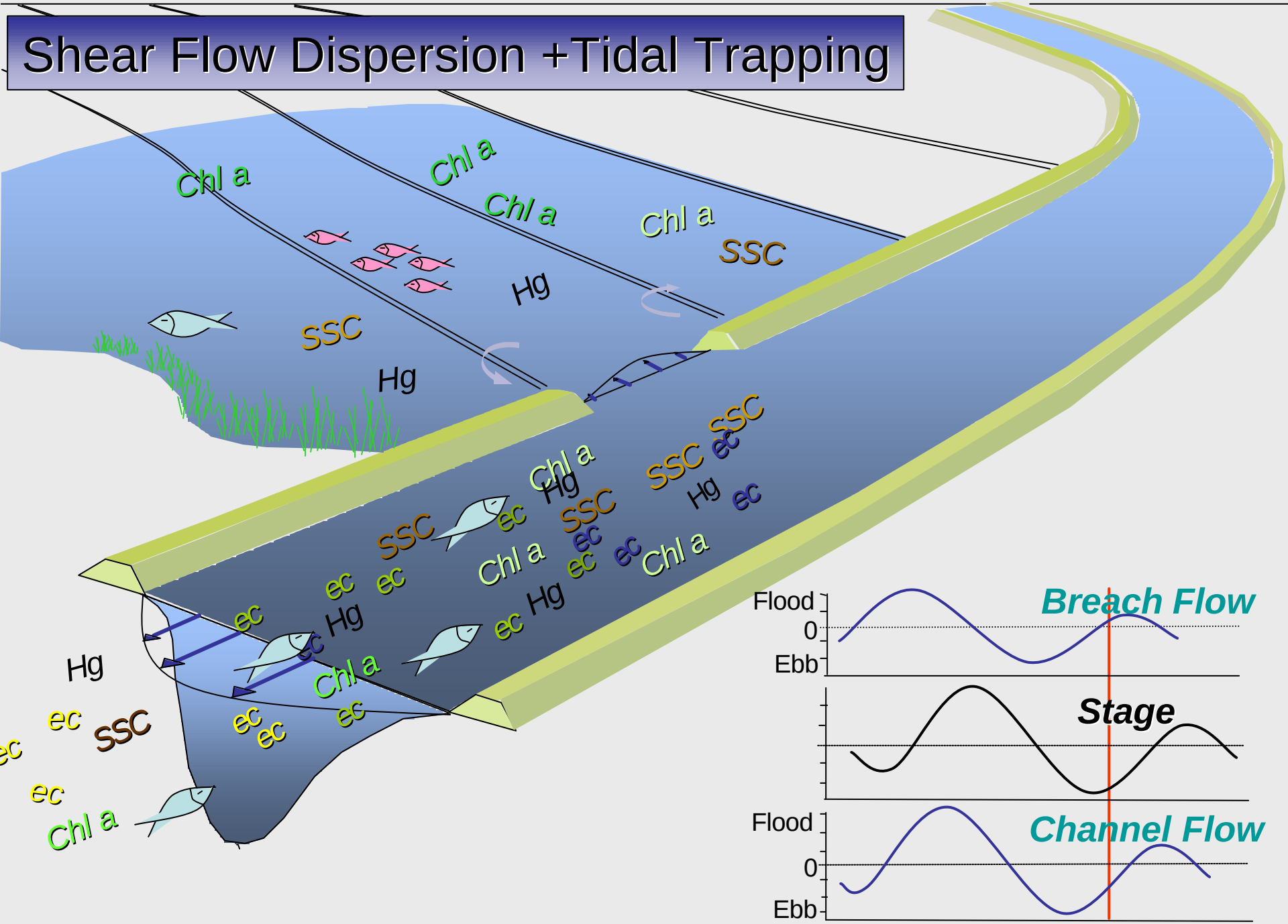

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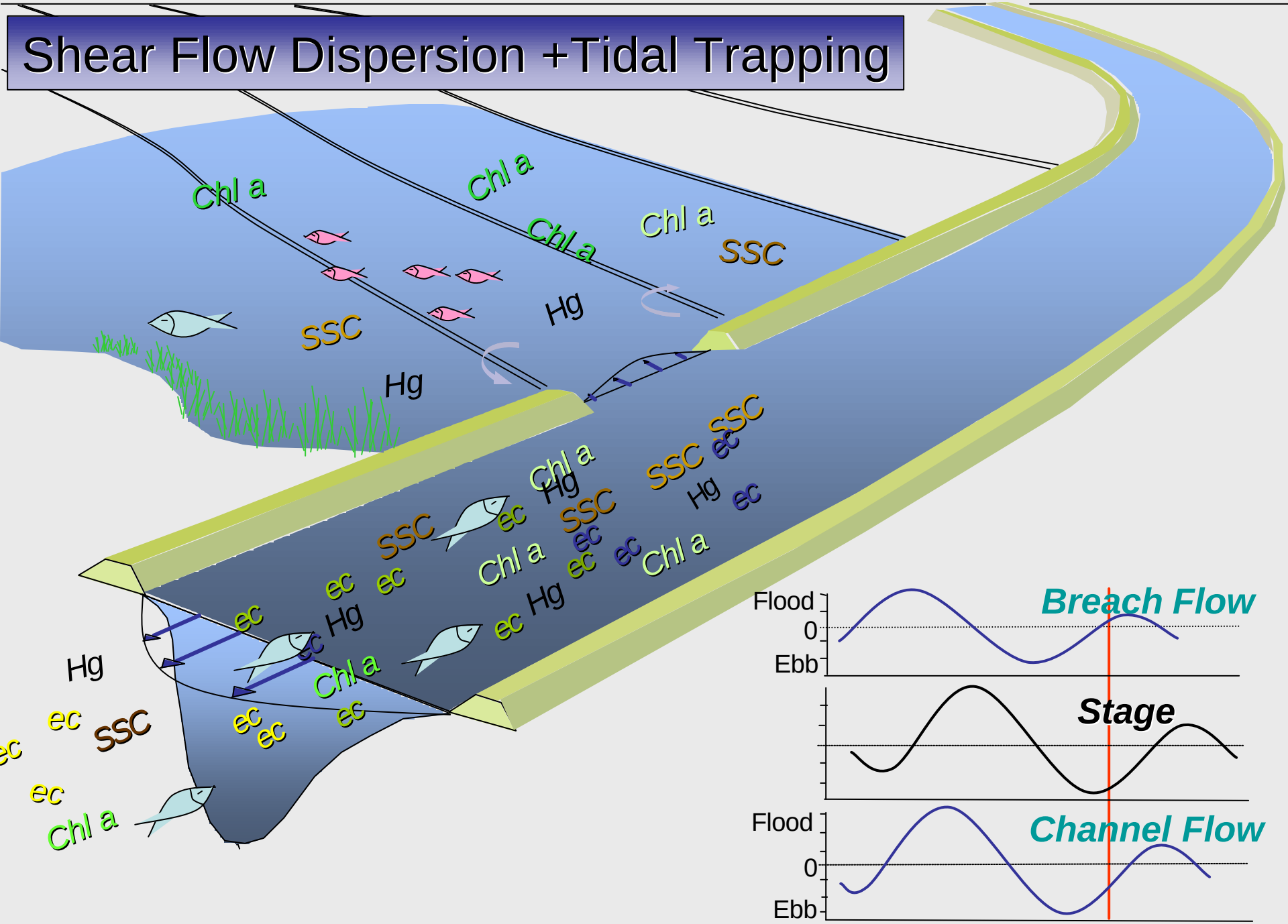
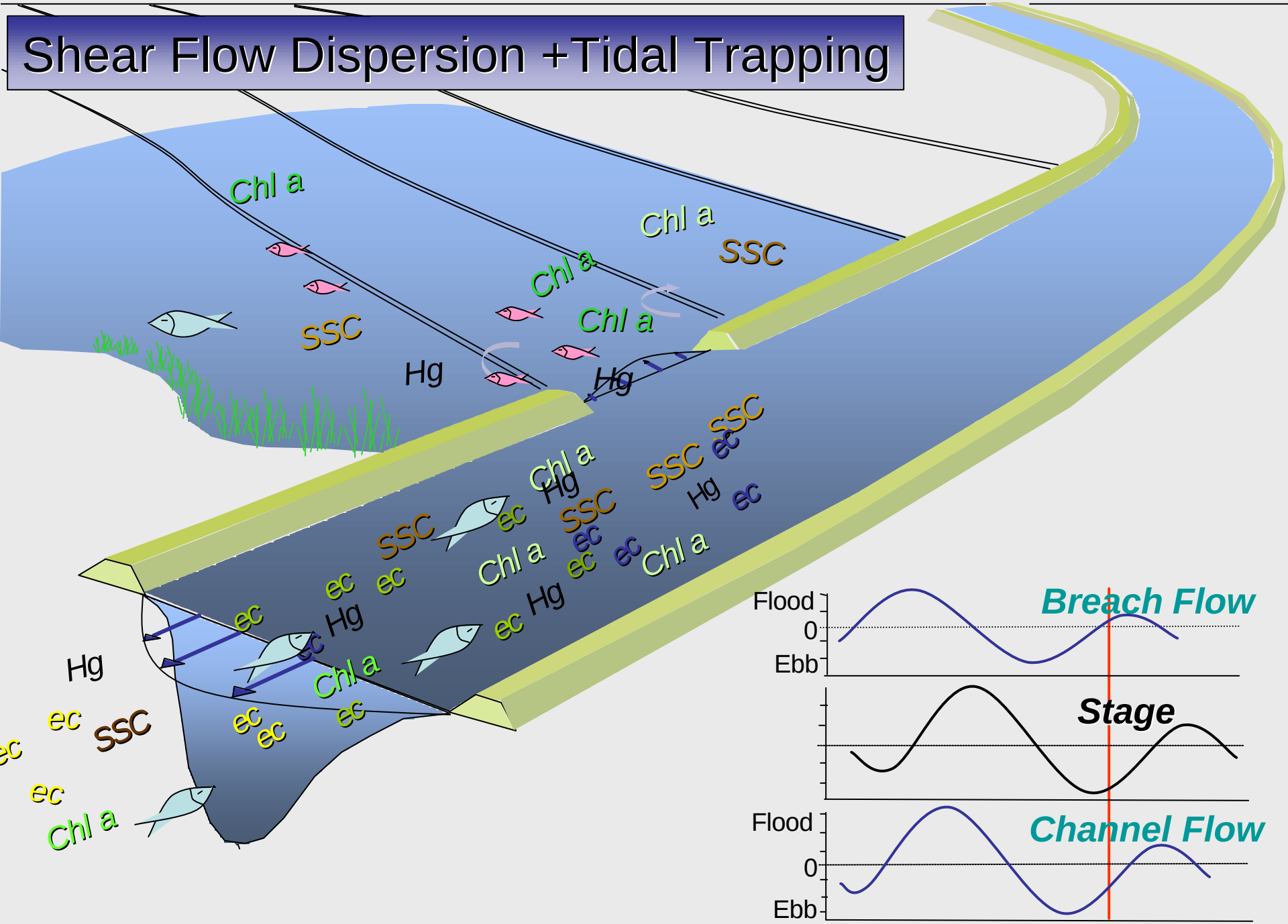
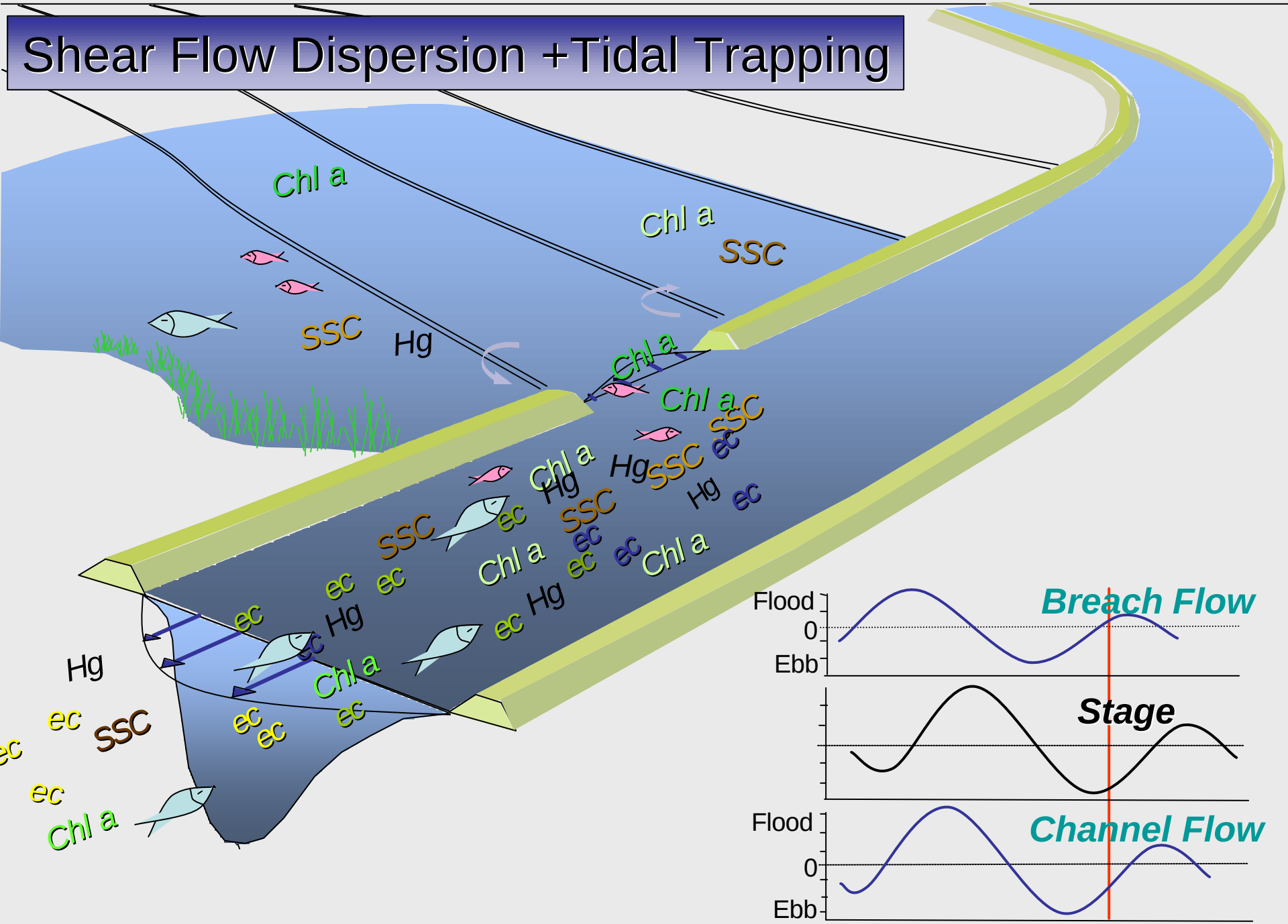


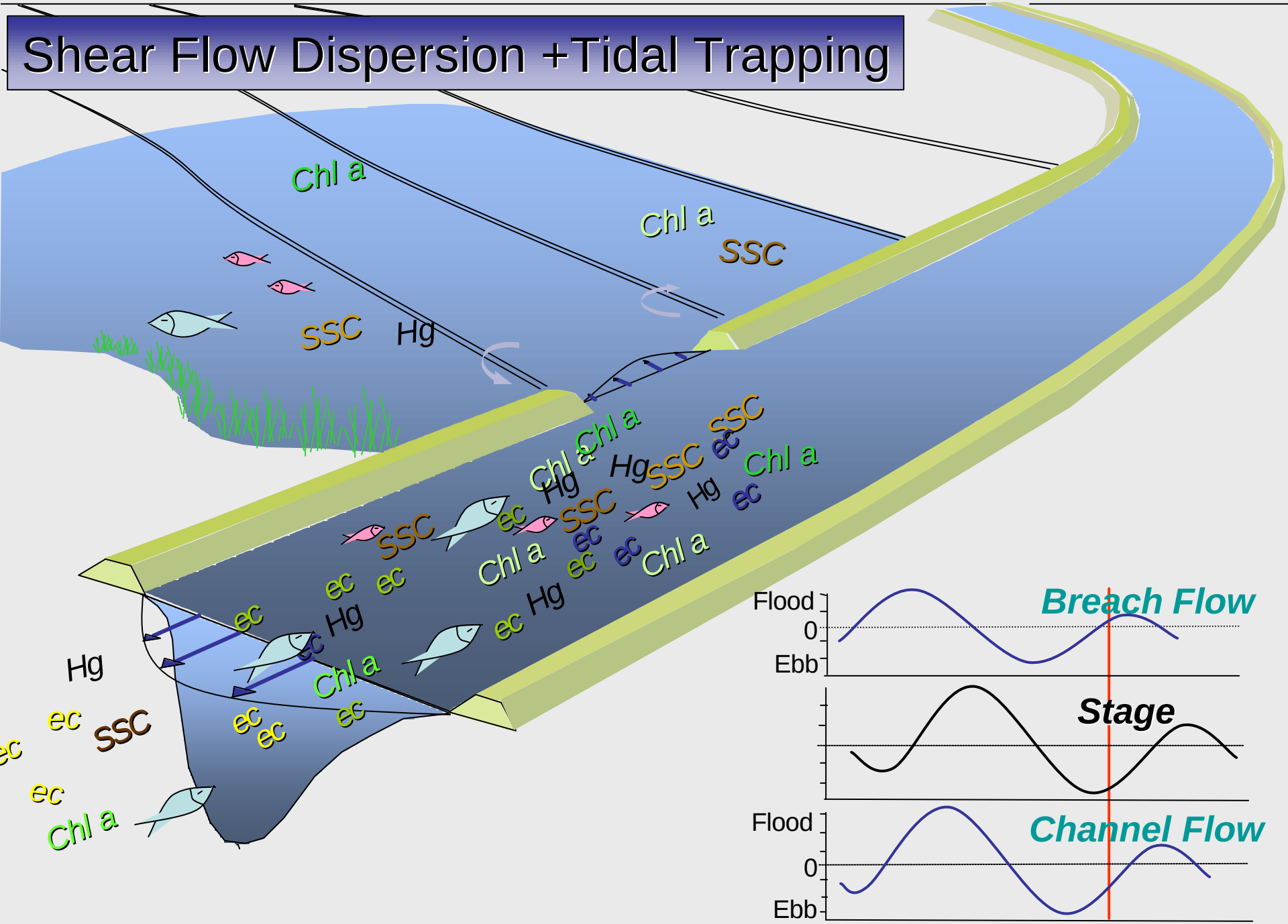
Shear Flow Dispersion +Tidal Trapping



Shear Flow Dispersion +Tidal Trapping

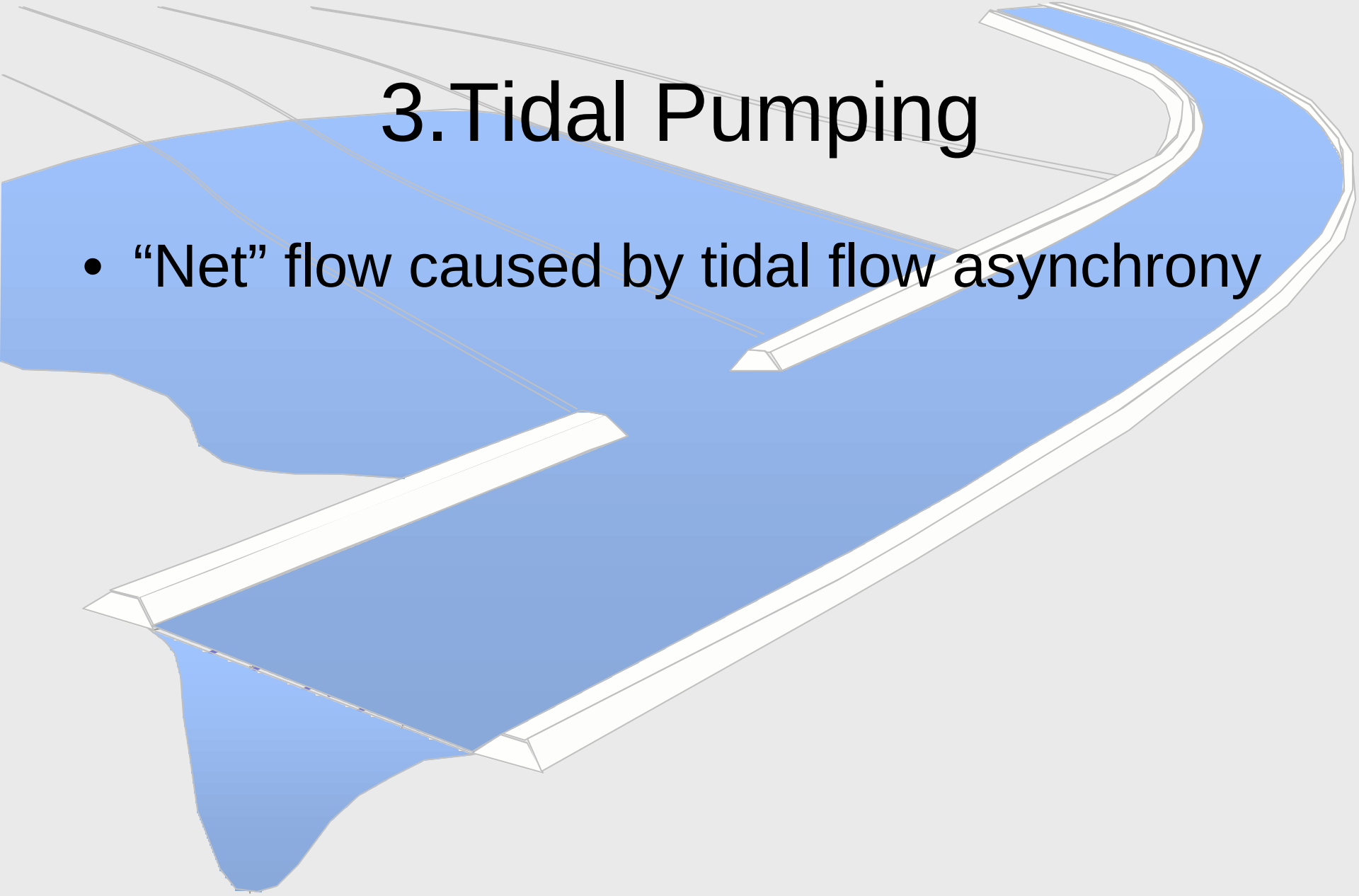


Shear Flow Dispersion +Tidal Trapping

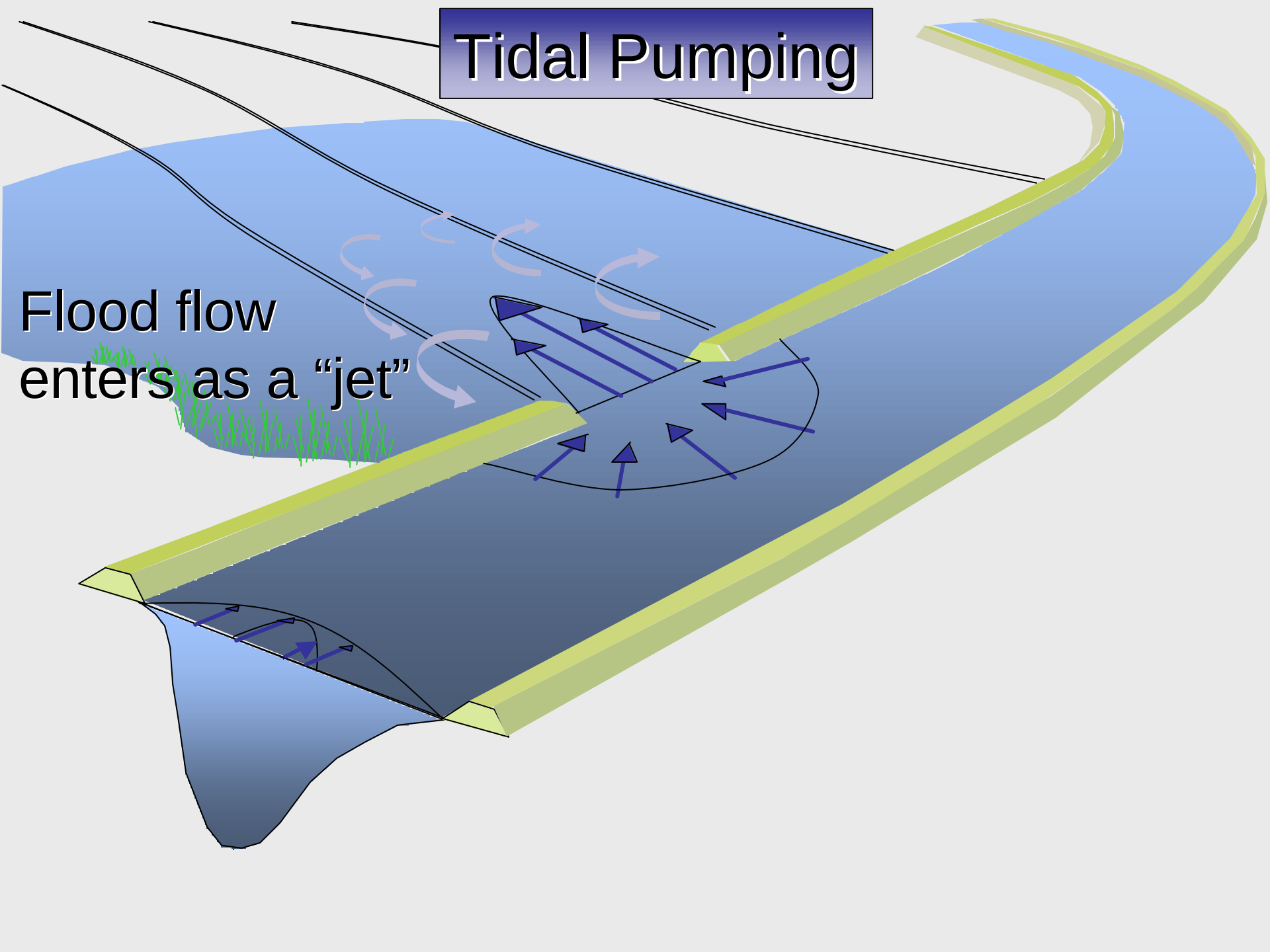


3.Tidal Pumping

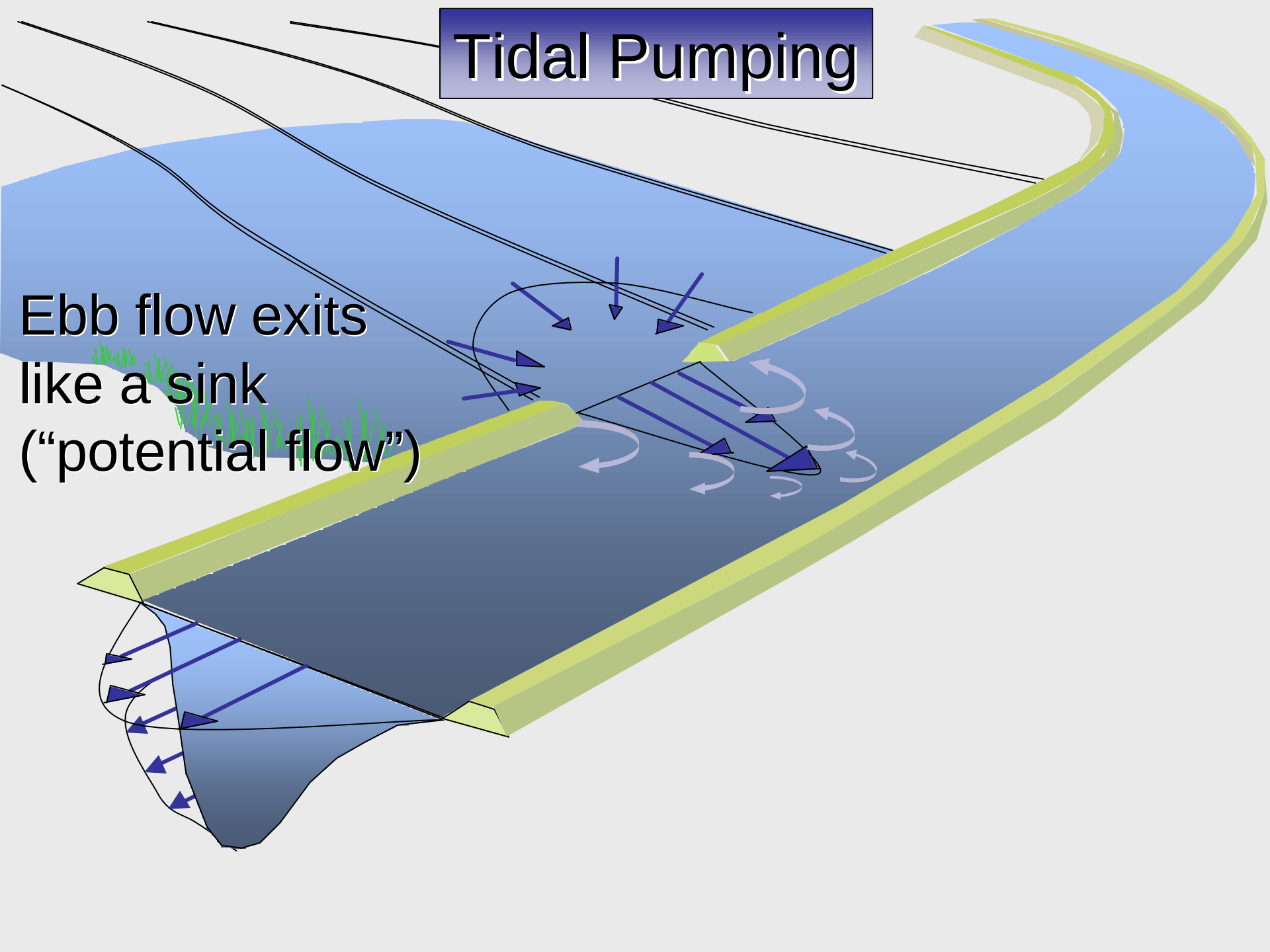
- “Net” flow caused by tidal flow asynchrony



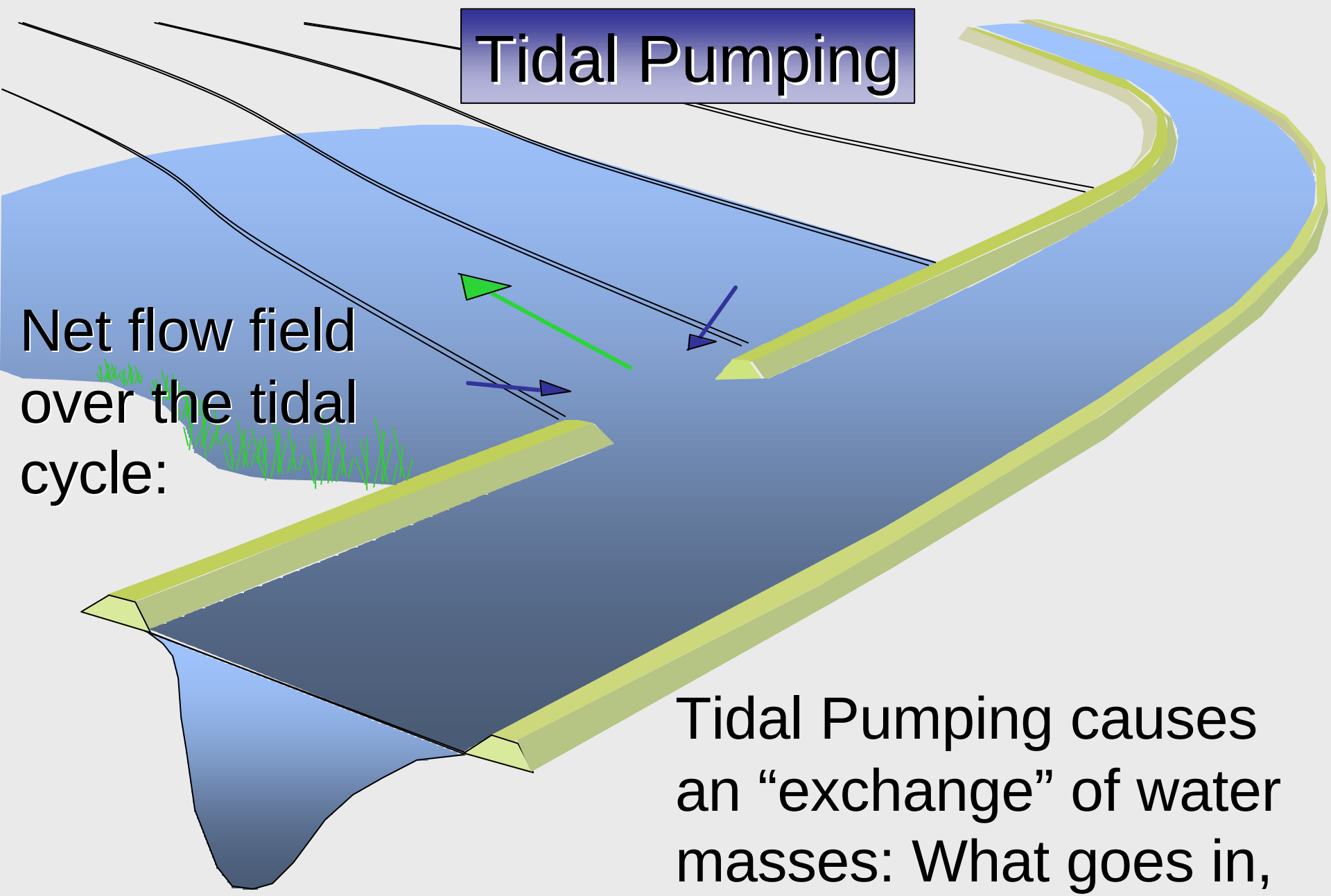
Tidal Pumping



Tidal Pumping



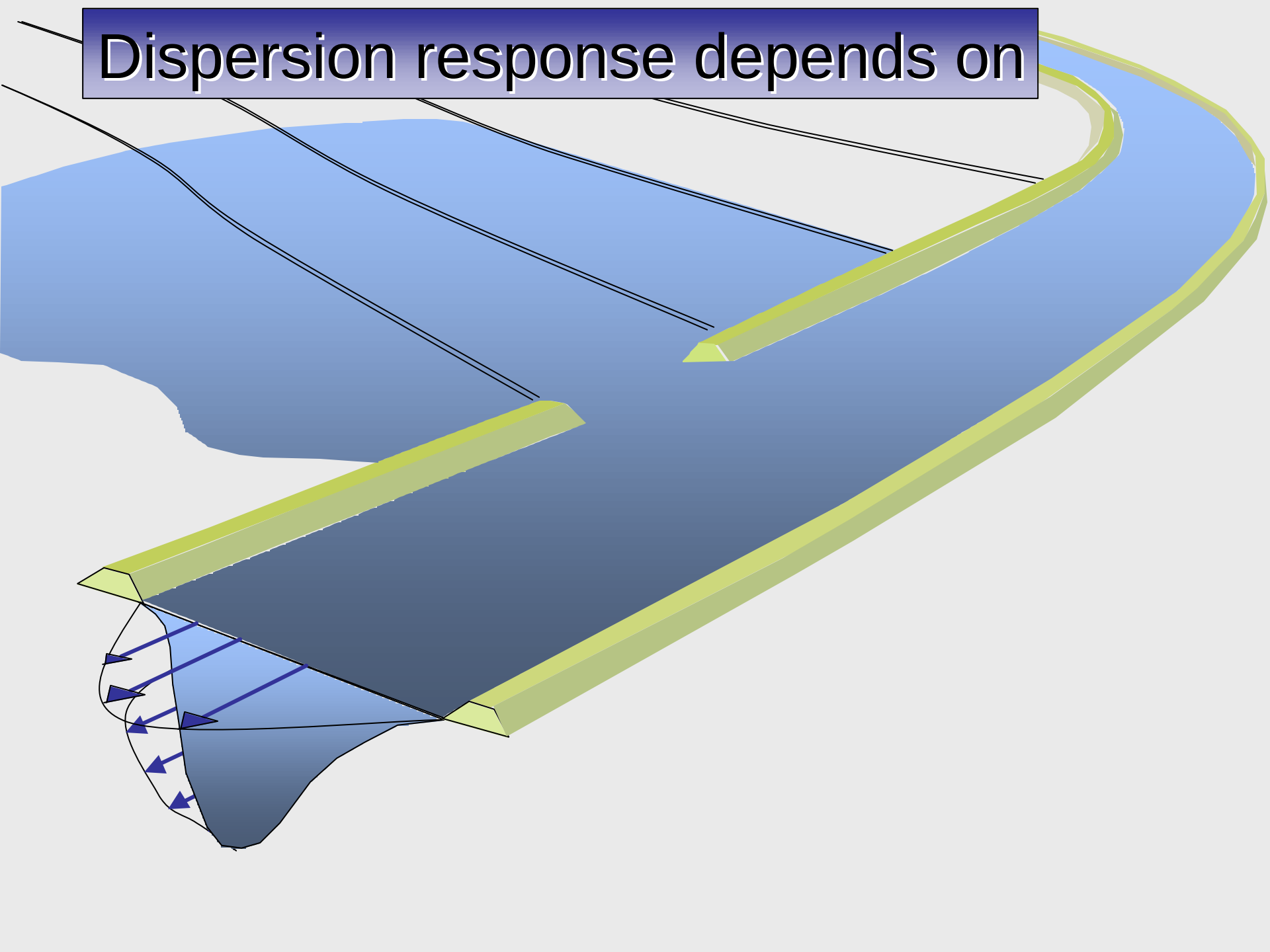
Tidal Pumping



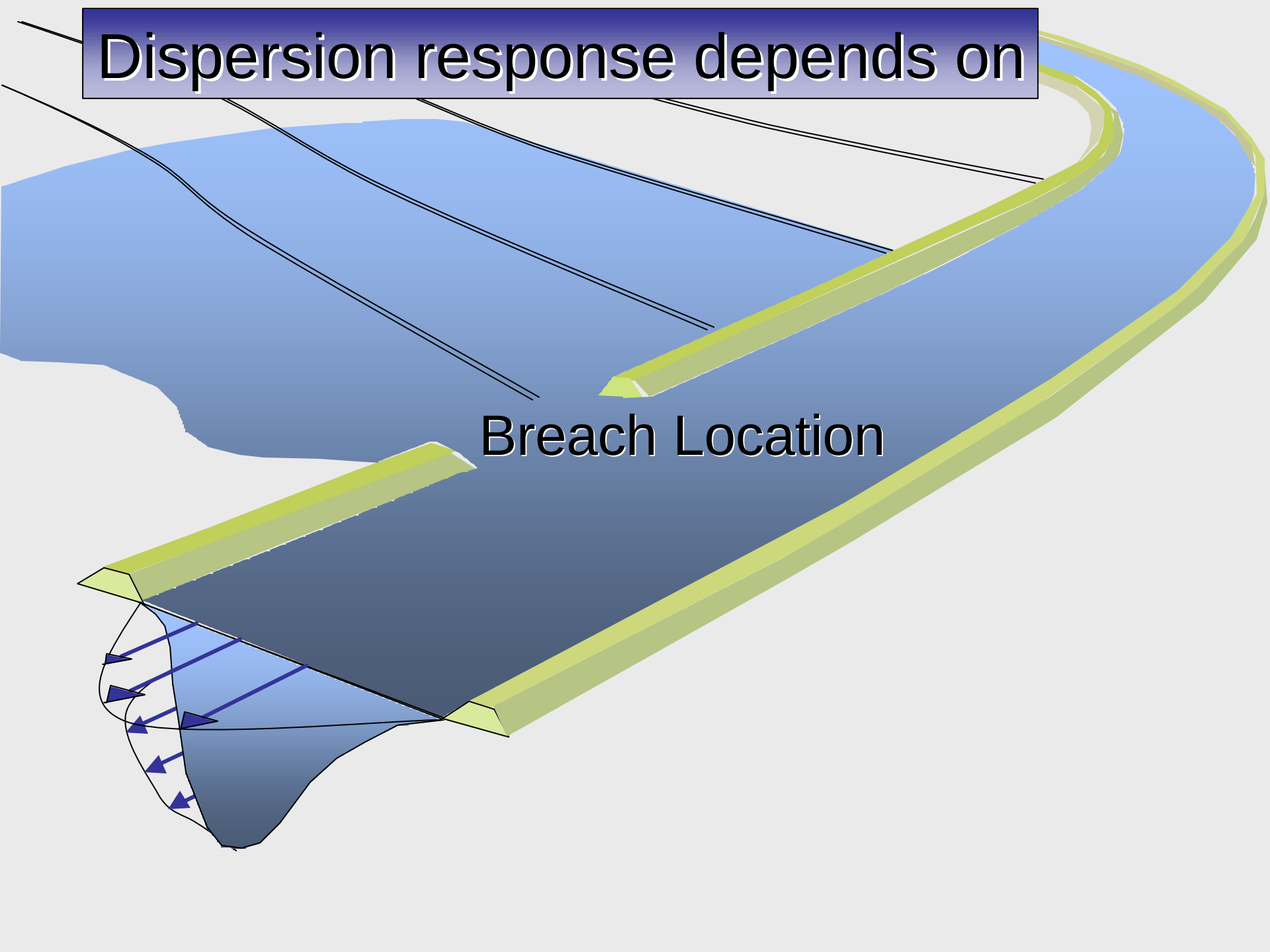
Net flow field over the tidal cycle:

Tidal Pumping causes an “exchange” of water masses: What goes in, doesn’t come out.

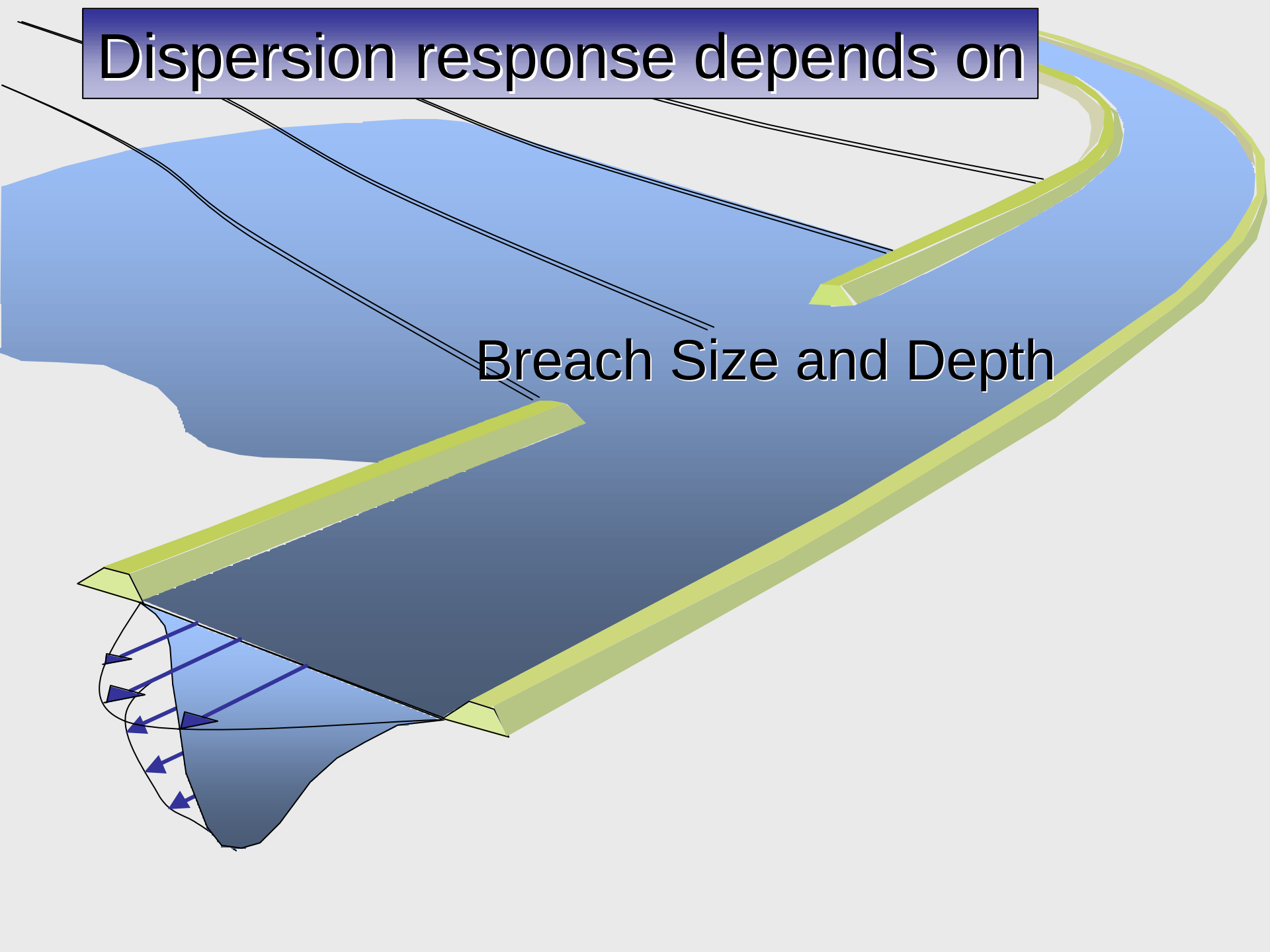
Dispersion response depends on



Dispersion response depends on



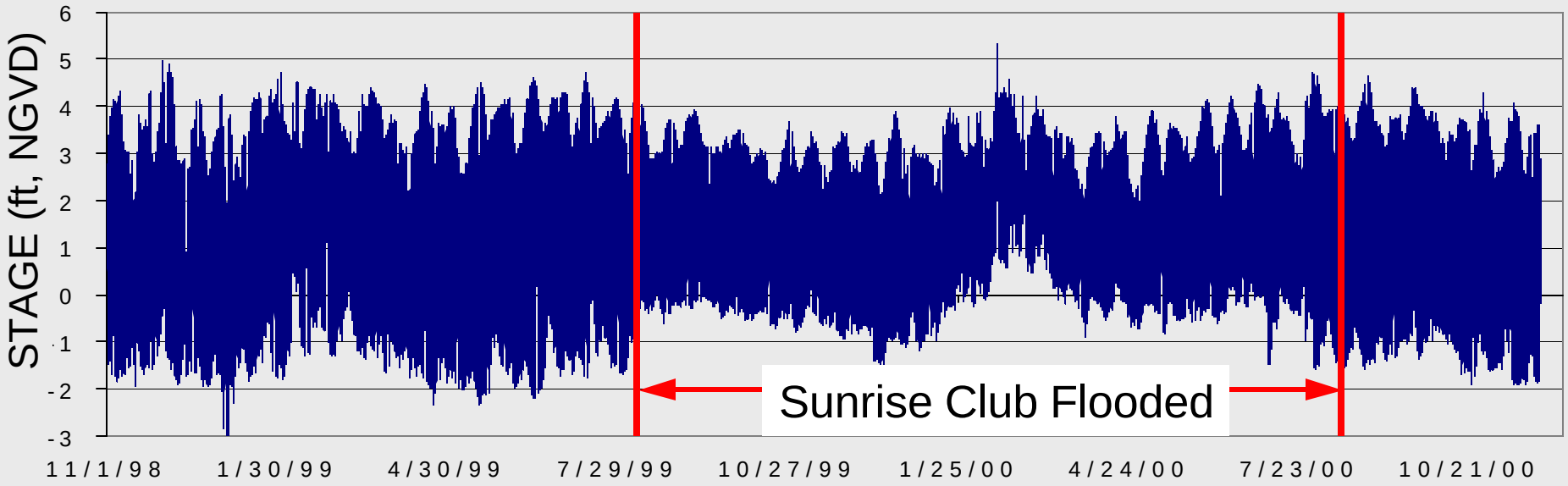
Dispersion response depends on

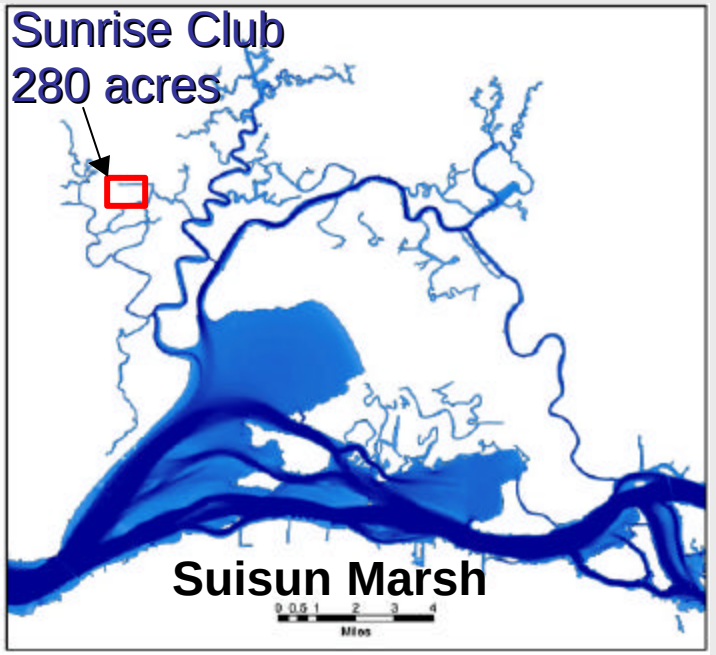


2. Restoration effect on tidal range

- Levee breaches dissipate tidal energy by imparting additional friction.
- Tidal range is generally reduced.

Tidal Range Reduction Due to Levee Breach



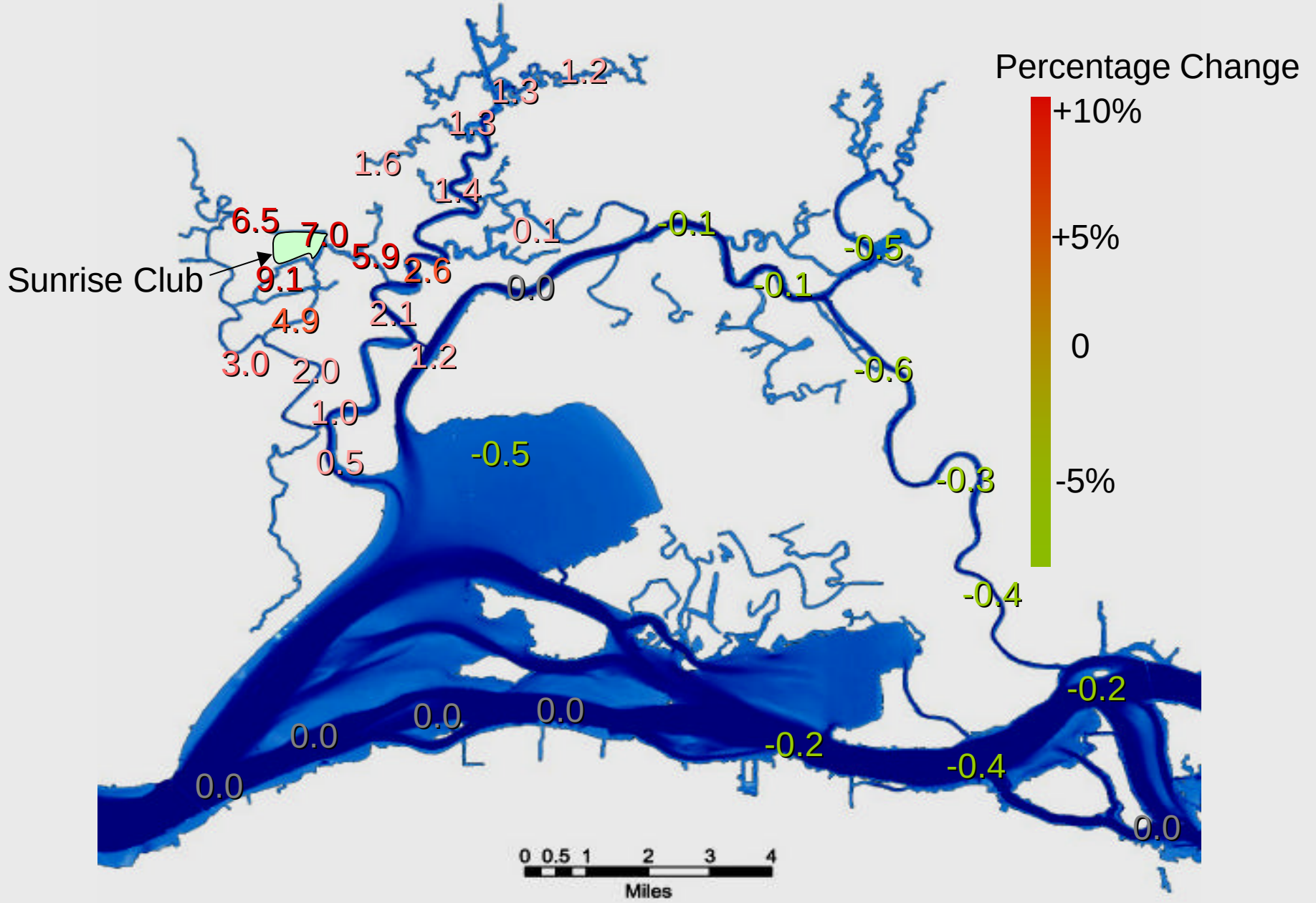


3. Modeling examples

Levee breach effect on regional salinity.

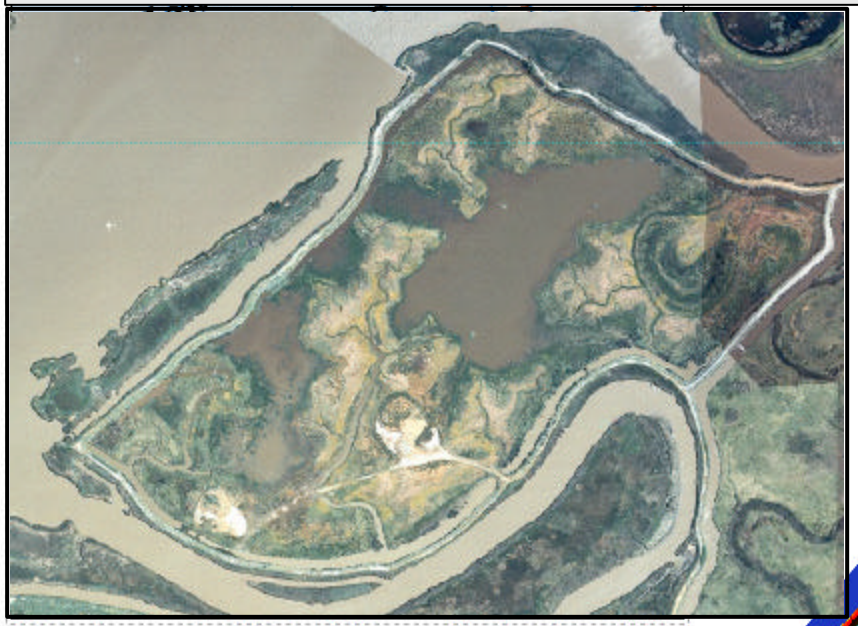
- Sunrise Club levee failure
- Blacklock restoration

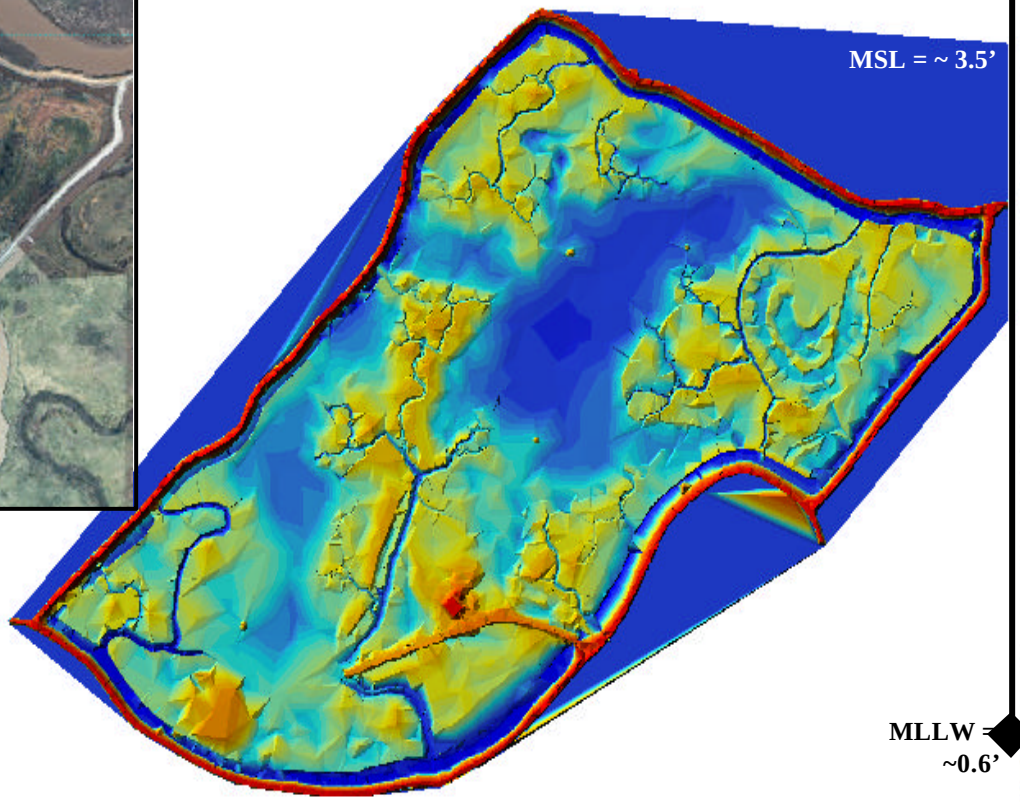
Regional Salinity Impact of Sunrise Club Levee Breach



Average of DSM1 and DSM2 Simulation of July 2000

Regional Salinity Impact of Blacklock Levee Breaches





Black Lock Elevations
August 2002

N

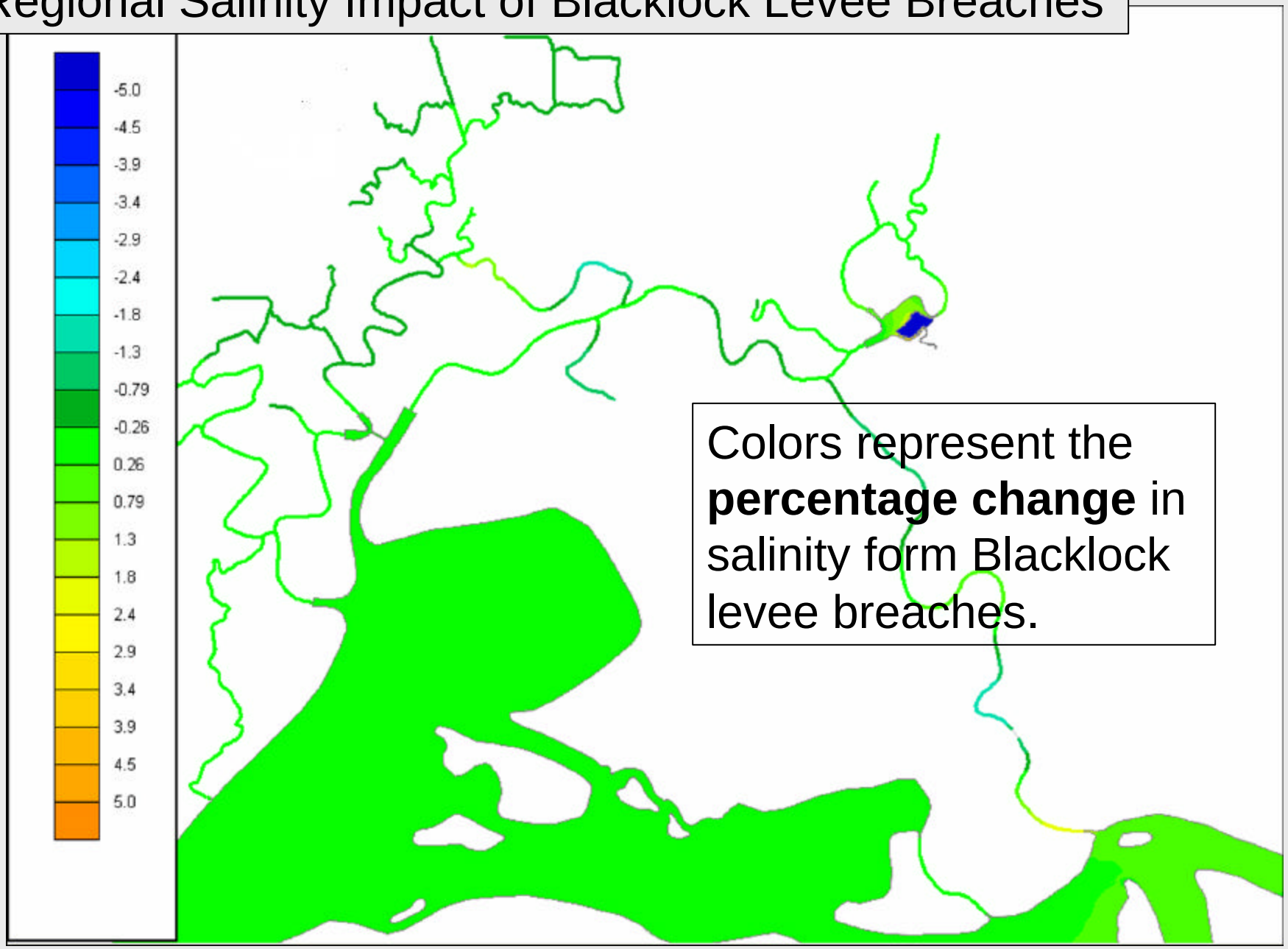
Suisun Marsh Branch
DWR-DES
24 Sep 2002

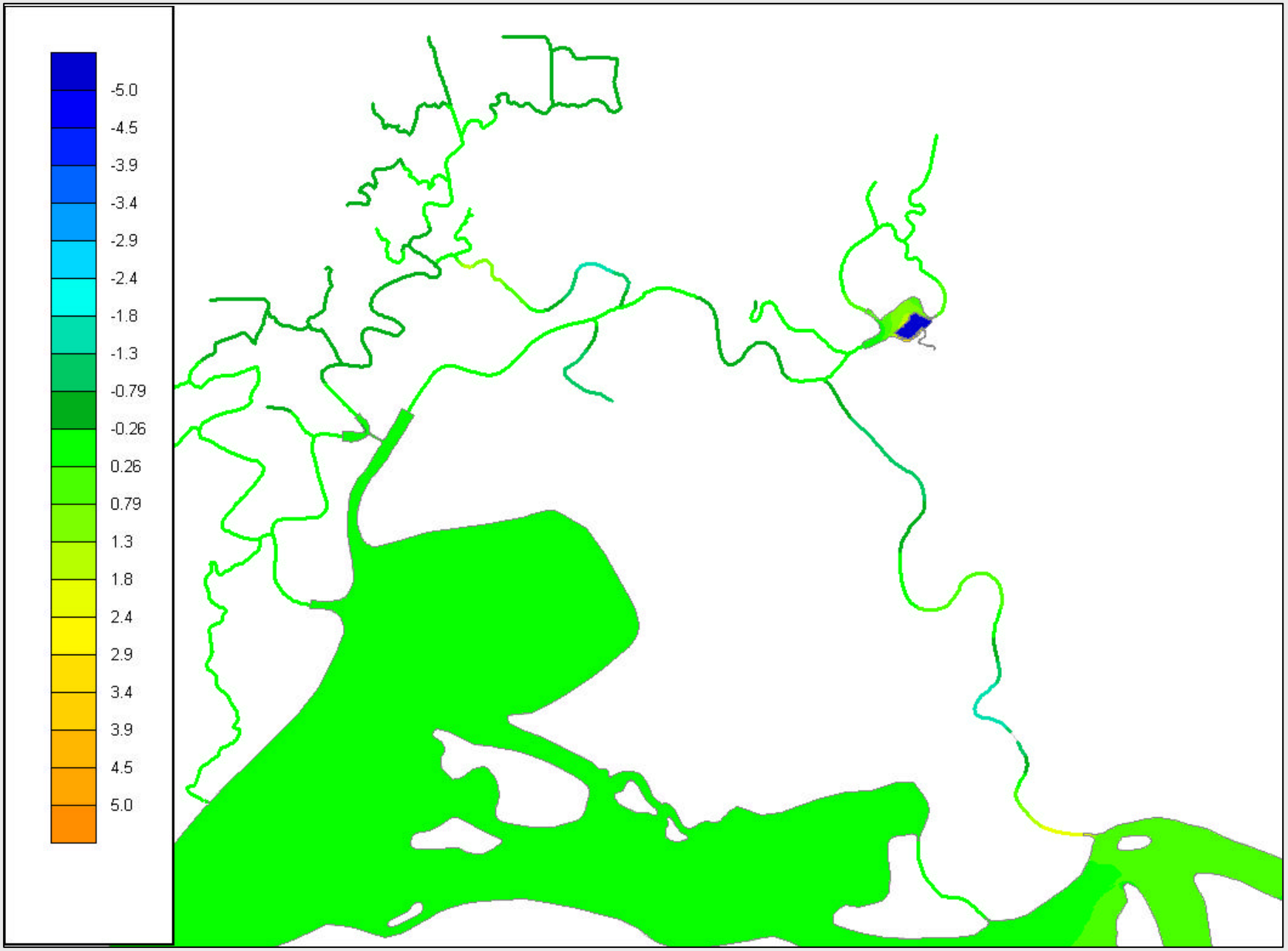
Regional Salinity Impact of Blacklock Levee Breaches

RMA 2/11 Model Simulation

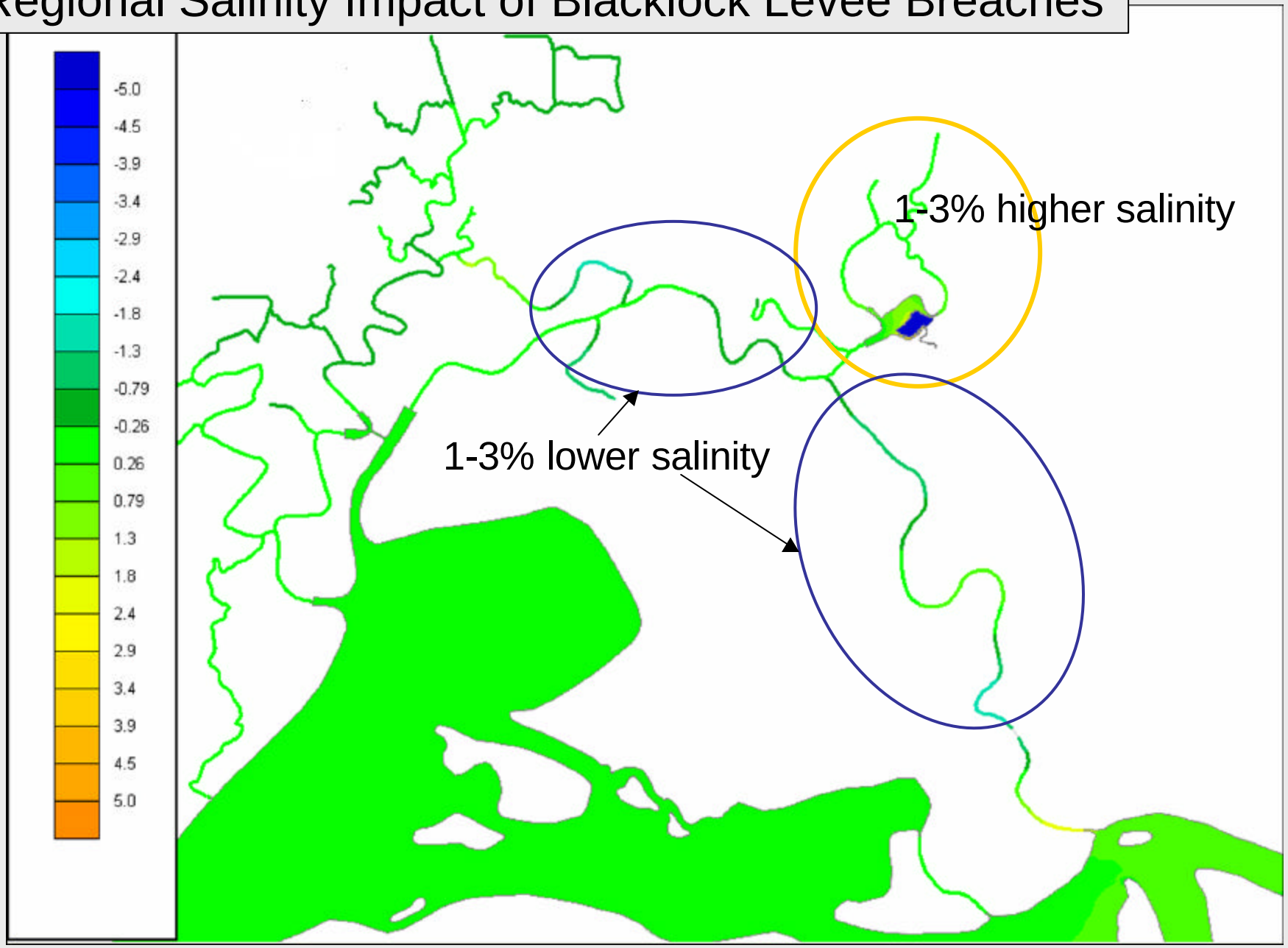
Two, fifty foot levee breaches

Regional Salinity Impact of Blacklock Levee Breaches

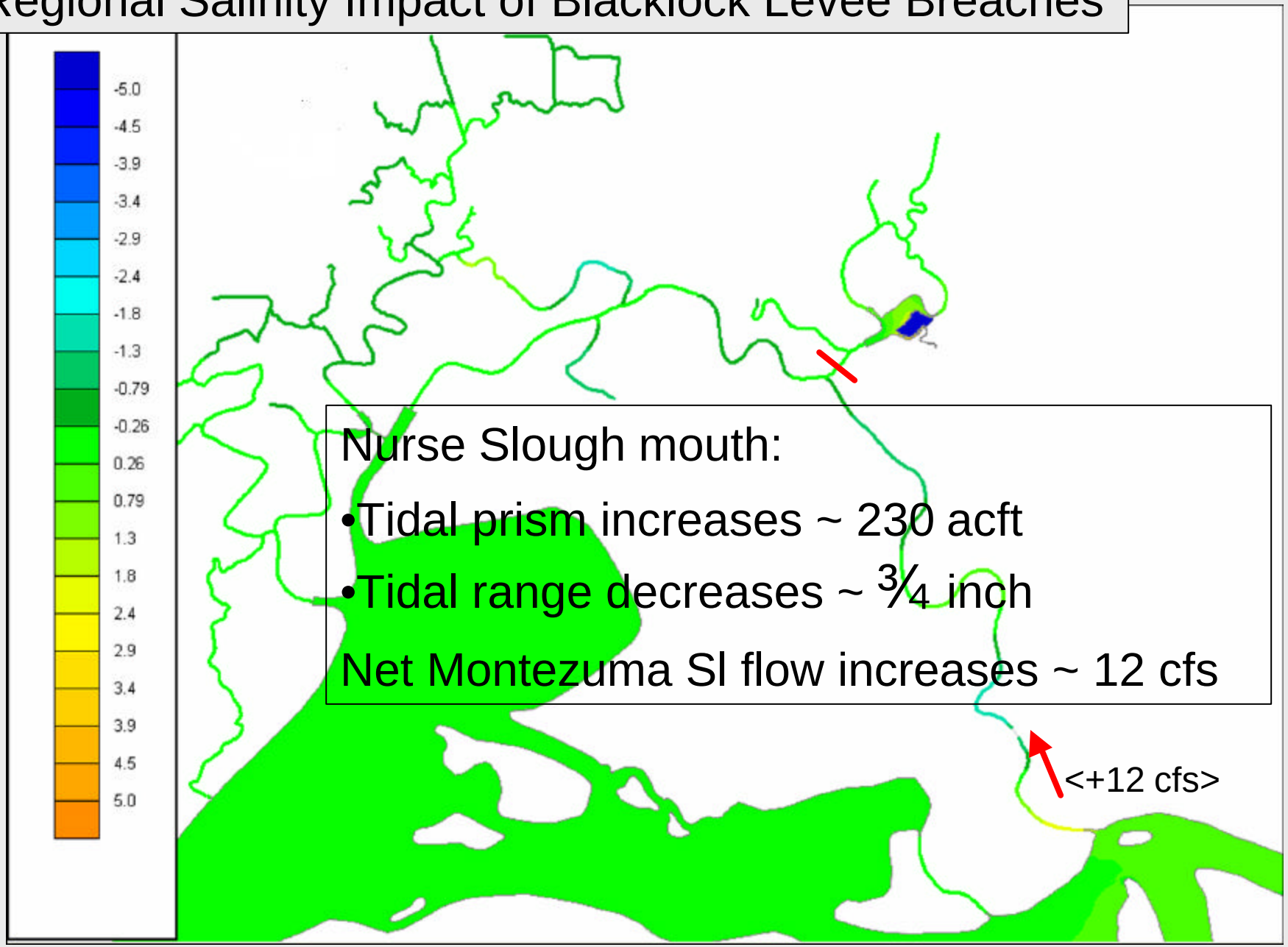



-5.0
-4.5
-3.9
-3.4
-2.9
-2.4
-1.8
-1.3
-0.79
-0.26
0.26
0.79
1.3
1.8
2.4
2.9
3.4
3.9
4.5
5.0

Regional Salinity Impact of Blacklock Levee Breaches



Regional Salinity Impact of Blacklock Levee Breaches



4. TM Restoration: good, bad, both?

Change geometry:

- change hydrodynamics and dispersive transport characteristics
- Tidal restoration areas will produce and consume scalars-- bad, good, both.

If TM restoration produces carbon:

- Good: generally more bioavailable, fuels estuarine food web.
- Bad: Contributes to THMFP, contaminant food web accumulation
- Both? (Potency vs. proximity-- transport is the key)
- Research: carbon production, quality, transport

If TM restoration produces fish:

- Good: if they’re predominantly native
- Bad: if they’re predominantly non-native.
- Both will be produced.
- Research: Does TM structure and function favor native fish?

If TM restoration reduces tidal range:

- Good: Takes pressure off levees
- Bad: Affects managed wetland drainage
- Both: Depends who you ask!
- Research: location and design determine energy dissipation potential

If TM restoration methylates mercury:

- Bad: concern for human and wildlife health
- “Good:” *if* CH_3Hg^+ production/reduction relatively less than present.
- Both: hopefully
- Research: Land use and spatial extent of oxic-anoxic transition in water or sediment.
- Research: exposure to what source water, with what phyto concentration, for how long.

Take home's redux

Tidal marsh restoration:

- Changes marsh "geometry"
- Affects tidal propagation over a wide area
- Produces and consumes good stuff and bad stuff.
- *Process understanding is the key to restoration success.*

Thank you

- Aaron Miller
- Brad Tom
- Kate Le
- Victor Pacheco
- Steve Culberson
- Jon Burau
- John DeGeorge

To do:

- Aaron: how wide are levee breaches?